

BARRY SGA

Sound Absorbing Dividers + Underside of Canopy
 Rear and Side Walls Added

Shooters within 1 second:

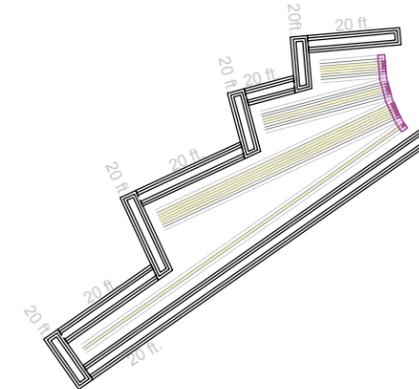
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms

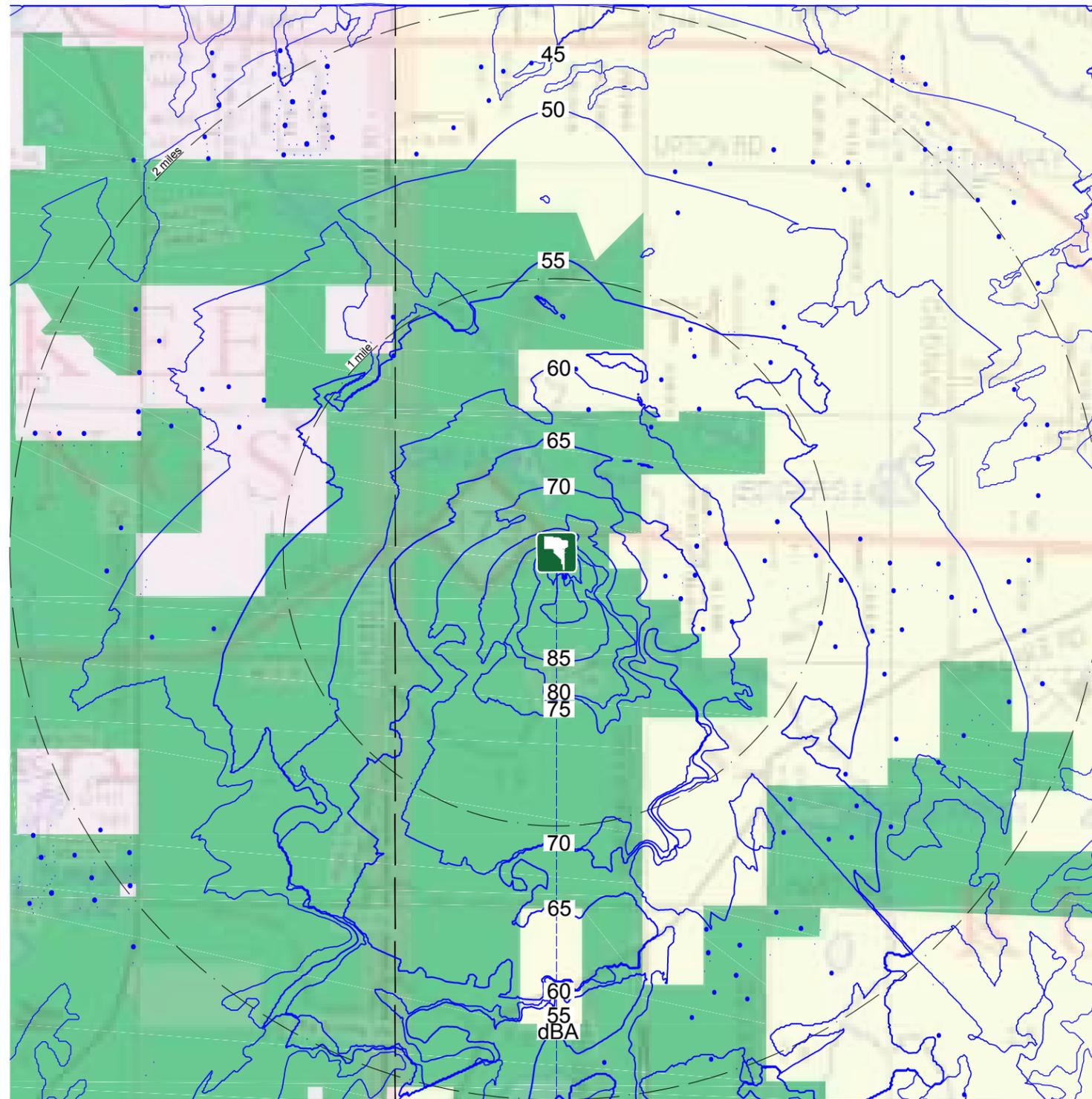
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- THORNAPPLE TOWNSHIP
No sound level limitations established
- IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
- 57 dBA Residential Zones
- 60 dBA Commercial
- 65 dBA Industrial
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure M-2



CHIEF NOONDAY

Sound Absorbing Dividers + Underside of Canopy
 Rear and Side Walls Added

Shooters within 1 second:

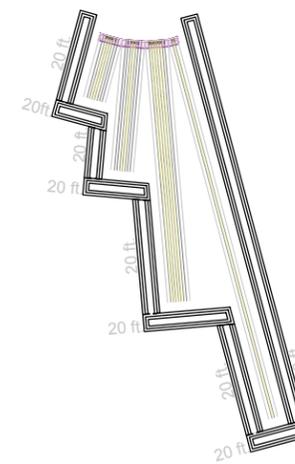
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. South

20 ft. End Berms
 20 ft. Side Berms

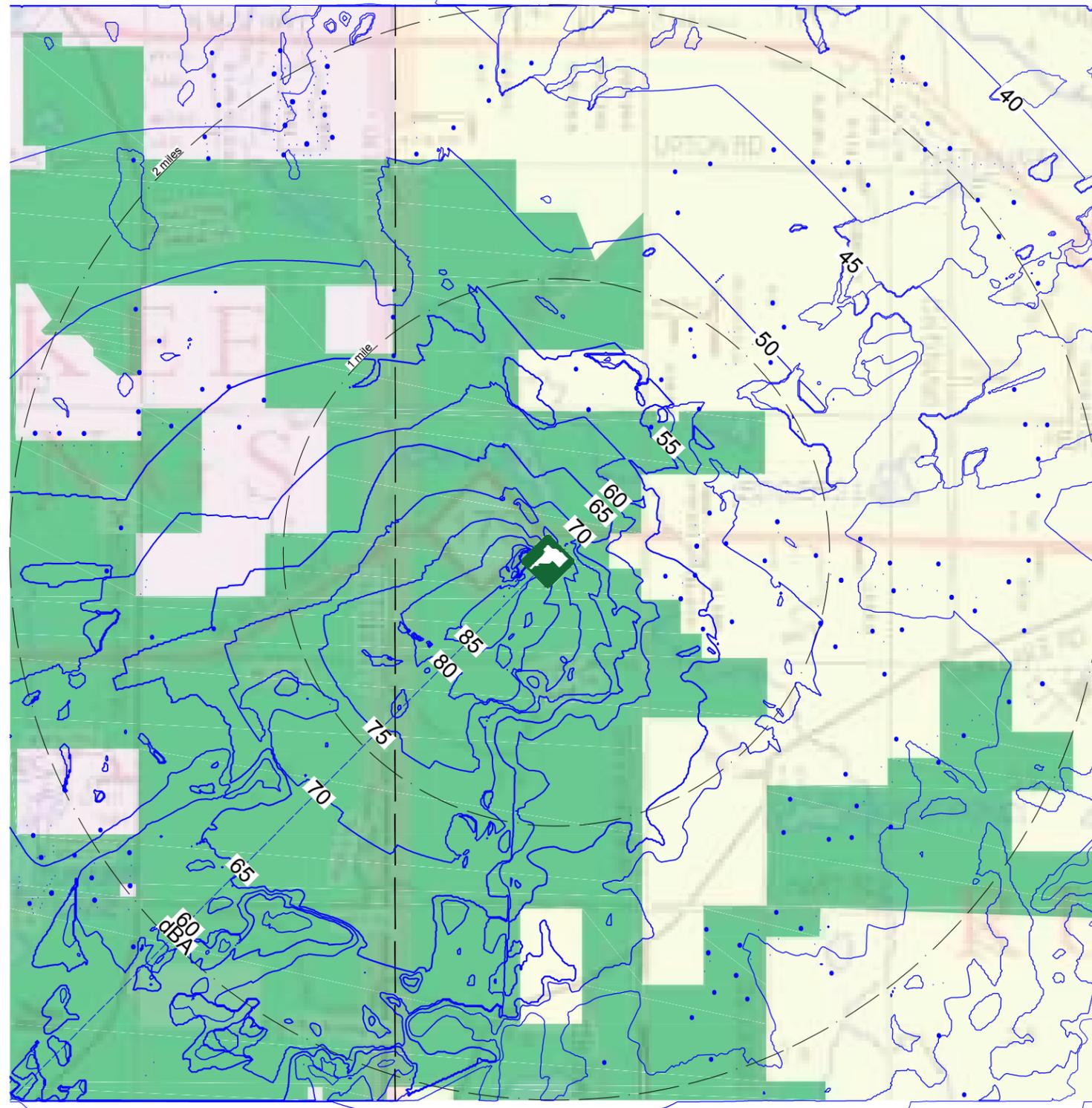
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure M-3



CHIEF NOONDAY

Sound Absorbing Dividers + Underside of Canopy
 Rear and Side Walls Added

Shooters within 1 second:

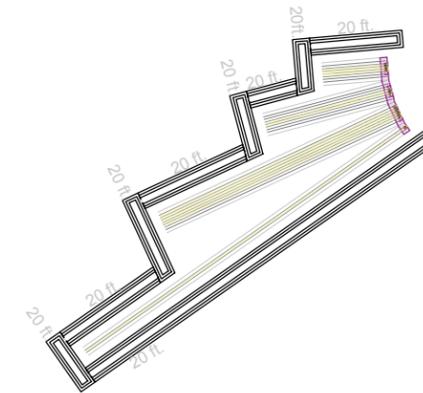
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms

Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure M-4

APPENDIX N: COMPUTER MODEL STUDY 9:

A 40 ft. Deep Extension Was Added to the Range Structure in the Direction of Fire Site 1 Alternate Range Orientation; Site 2 Base and Alternate Range Orientation Typical Day Scenario 20 ft. tall berm

Computer model study 9 was conducted with side and rear walls added to the range structure so the firing positions were open only in the direction of fire. A 40 ft. deep extension was added to the roof/ceiling of the range structure with the underside of the roof lined with a sound absorbent panel mounted on plywood. The side and rear walls WERE covered with the sound absorbent facing used in Computer Model Study 8. The sound absorbent material on the inside face of the partitions dividing the individual lanes described in Computer Model Study 7 were also included in this scenario. The models were run on Site 1: Barry State Game Area Existing Range Site with the direction of fire to the east and southwest with the typical day scenario and Site 2: Barry State Game Area Chief Noonday Site with the direction of fire to the south and southwest with the typical day scenario.

1. The “typical day” had 5 shooters firing a .223 caliber rifle on the 100 yard range; 1 shooter firing a .223 caliber rifle on the 150 yard range; 2 shooters firing a 12 gauge Remington shotgun on the 50 yard range; and 3 shooters firing a 0.40 caliber handgun on the 25 yard range within a 1 second time period.
2. The wind condition in the base model was modeled as downwind with 1 to 11 mph wind as in computer model studies 1 and 2.
3. The 50°F and 70% relative humidity condition was used in the models.
4. A 40 ft. deep extension was added to the range structure. The underside of the extension was lined with a sound absorbent material installed over plywood.
5. The side walls and rear wall of the range structure were also included in this model so that the range was only open in the direction of fire. Wood frame walls were built between each firing lane with plywood covering. Sound absorbent panels were installed on the sides and ceiling of each lane as well as on the side and rear walls of the entire range structure as in Computer Model Studies 7 and 8.
6. The direction of fire was to the east and southwest for Site 1 and to the south and southwest for Site 2.
7. The berm height of 20 ft. was used in the reference model.
8. The sound levels shown on the noise contour maps are LA eq in dBA.

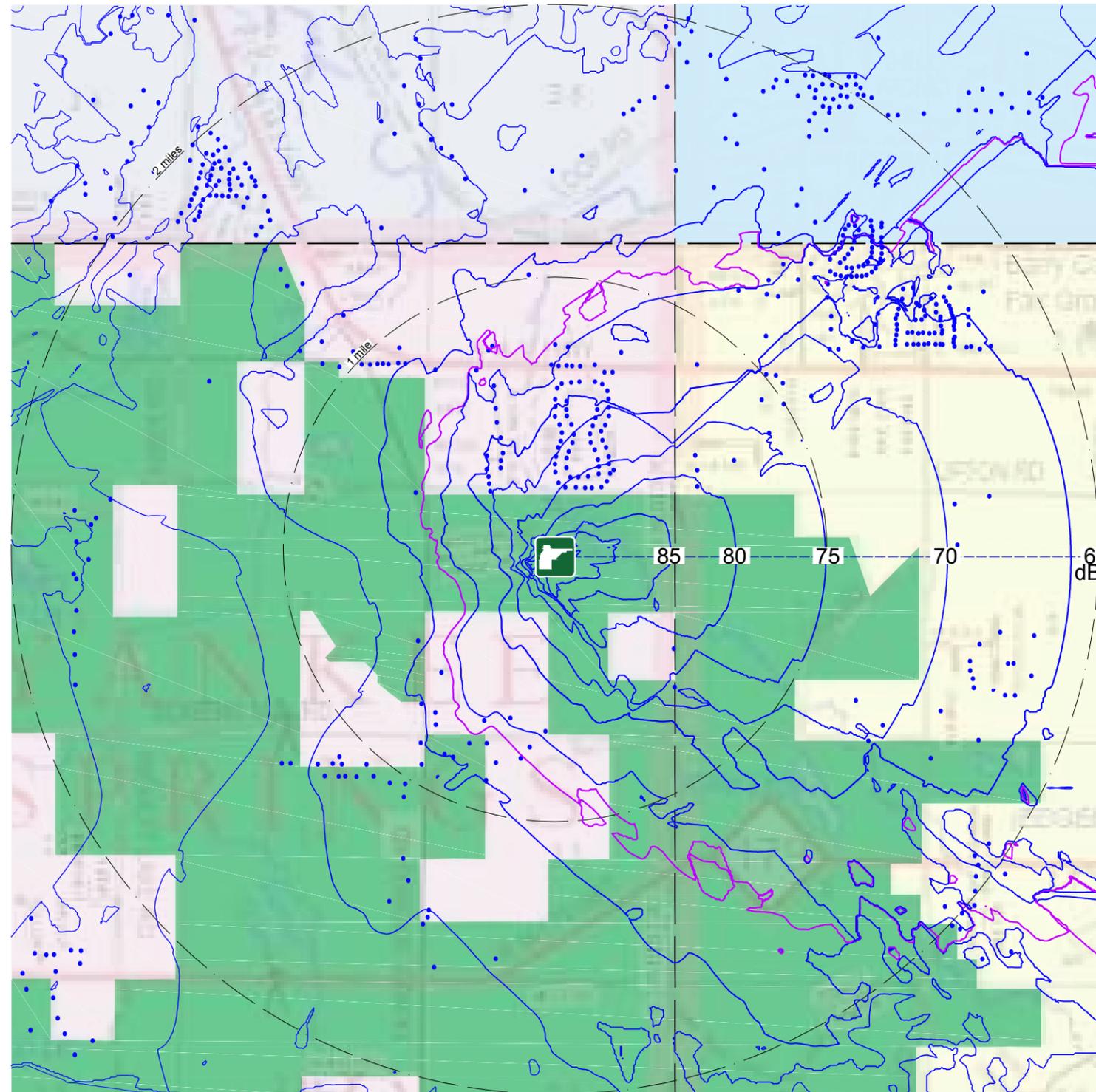
In Experiment 9, a 40 ft. deep roof lined with sound absorbent material was constructed on the down range side of the range building in addition to the solid side walls and rear wall added to the range building in Experiment 8 and the solid dividers lined with sound absorbent material in Experiment 7 are installed between each lane in the Site 1: Barry SGA range oriented to the east and to the southwest and Site 2: Chief Noonday range oriented to the south and to the southwest with the 20 ft. tall downrange berm and the “typical day” scenario in Experiment 7. A sound absorbent lining panel is added to the rear wall, side walls, interior lane dividing walls and the ceiling of each lane in the range building. This locates each shooter in a sound absorbent enclosure on 3 sides with a 40 ft. deep roof structure that reduces sound propagating out of the range building.

The linear pressure score is reduced by approximately 92% for the Site 2: Chief Noonday range oriented to the southwest and by 85% when oriented to the south. The linear pressure score is reduced by approximately 77% for the Site 1: Barry SGA when oriented to the southwest and by 66% when oriented to the east.

The rough order of magnitude cost for installing the 40 ft. extension of the roof, the side walls, rear wall, solid dividers in each of the lanes and lining the ceiling and walls of each lane with a weather-resistant sound absorbing panel such as Troy Board manufactured by Troy Acoustics is \$444,100.

Table N-1. Summary table of rating points for each scenario tested in Experiment 9.

TYPICAL DAY 11 SHOOTERS 20 FT BERM				
Site	DOF	Lin Press	dB	PTS
SITE 2: Chief Noonday	SW	815	79	1616
SITE 2: Chief Noonday	S	1,456	82	1455
SITE 2: Chief Noonday Reference	S	4,630	87	1785
SITE 1: Barry SGA	SW	16,071	92	1984
SITE 1: Barry SGA	E	24,427	94	2418
SITE 1: Barry SGA Reference	E	59,135	98	2140



BARRY SGA

Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

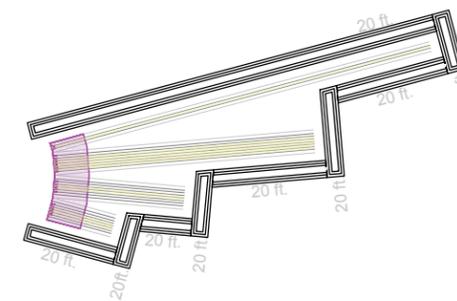
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. East

20 ft. End Berms
 20 ft. Side Berms

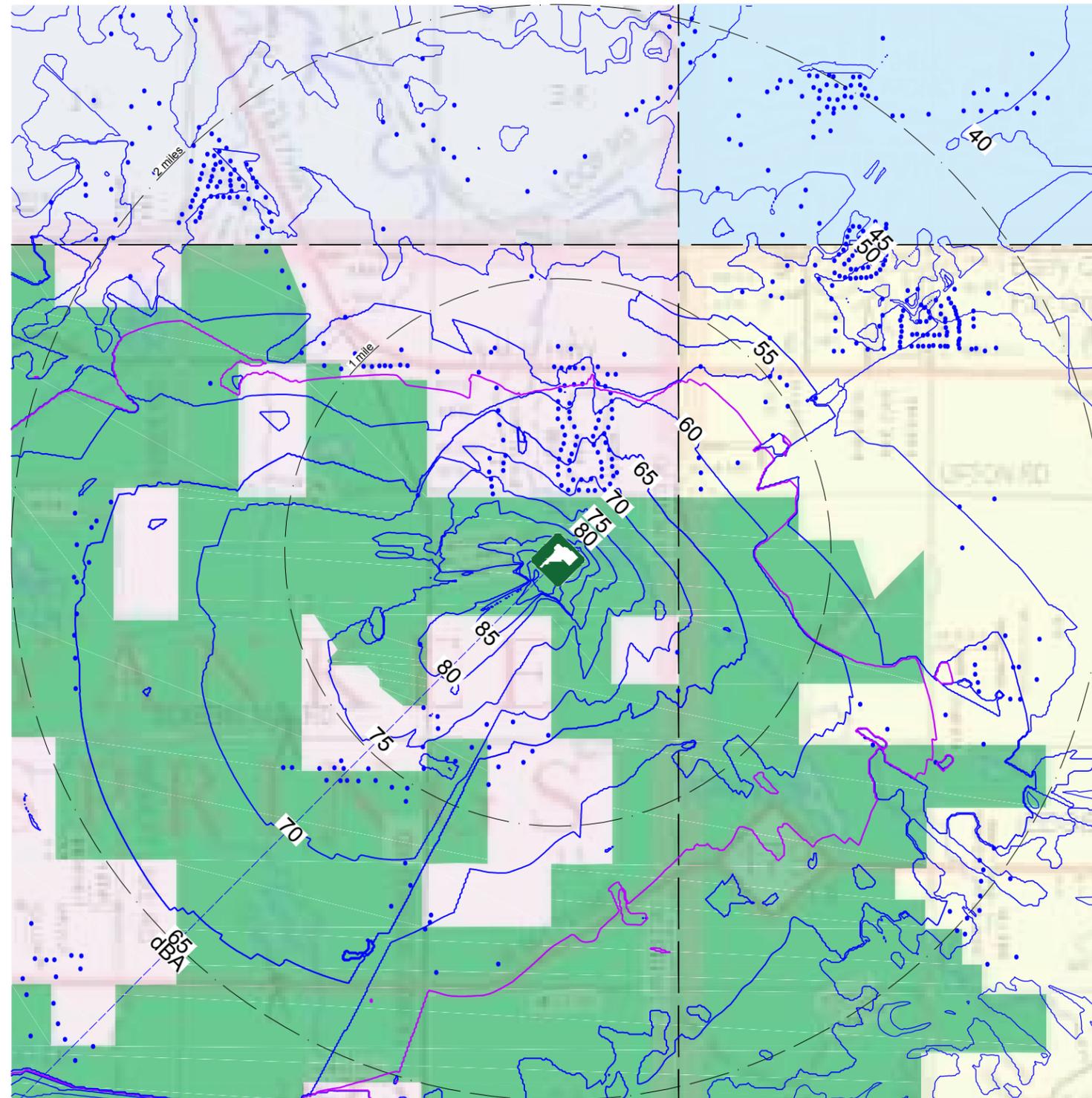
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
 - THORNAPPLE TOWNSHIP
No sound level limitations established
 - YANKEE SPRINGS TOWNSHIP
No sound level limitations established
 - IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
 - RUTLAND TOWNSHIP
No sound level limitations established
 - 57 dBA Residential Zones
 - 60 dBA Commercial
 - 65 dBA Industrial
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure N-1



BARRY SGA

Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

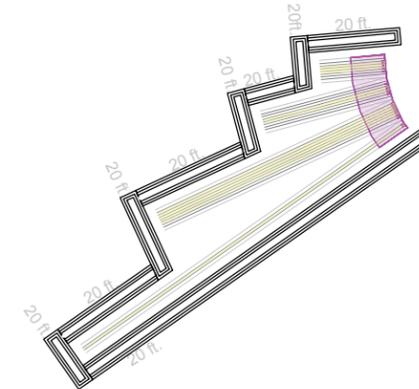
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms

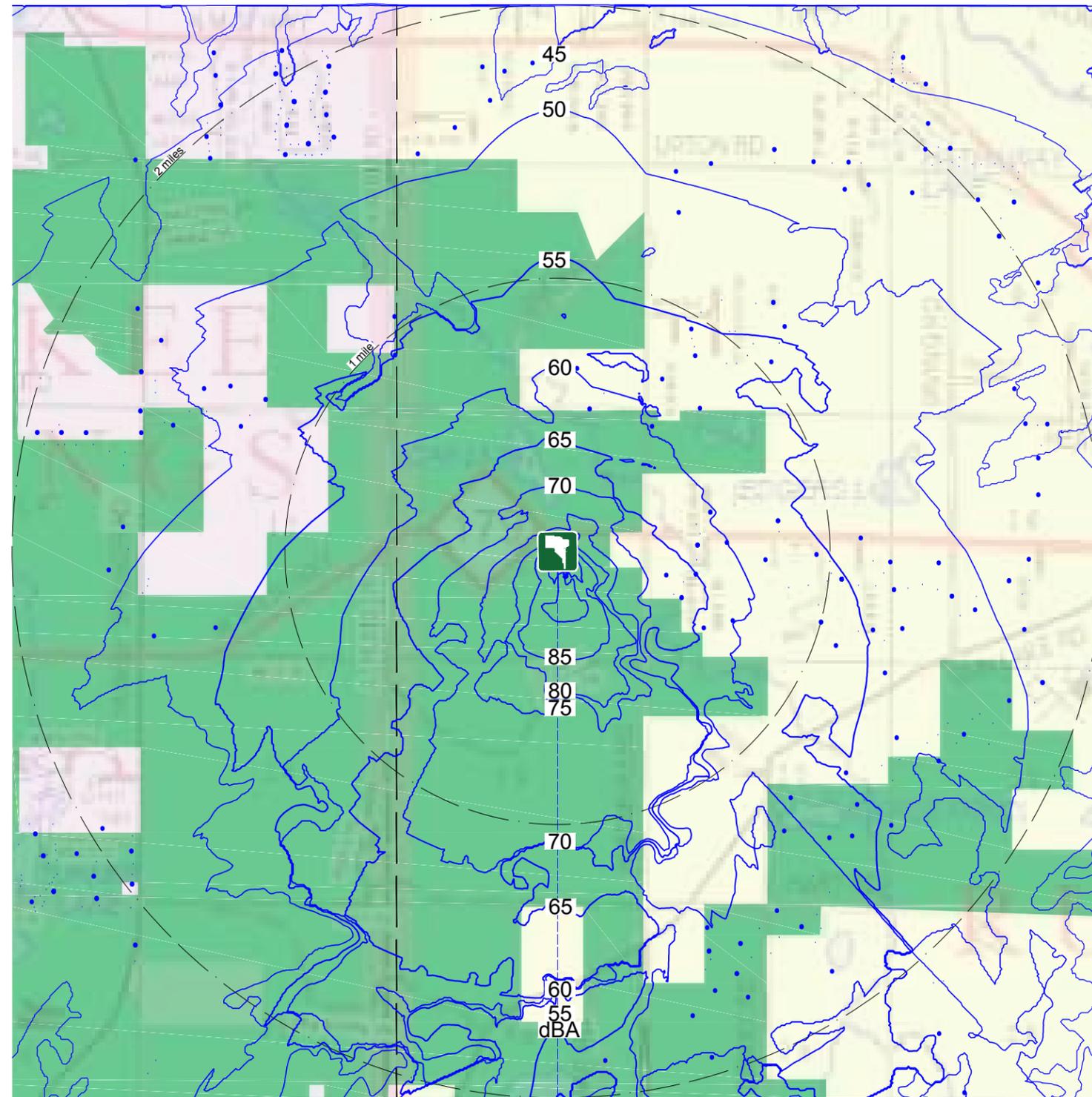
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- THORNAPPLE TOWNSHIP
No sound level limitations established
- IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
- 57 dBA Residential Zones
- 60 dBA Commercial
- 65 dBA Industrial
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure N-2



CHIEF NOONDAY

Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

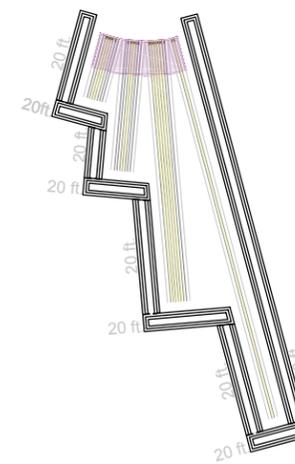
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. South

20 ft. End Berms
 20 ft. Side Berms

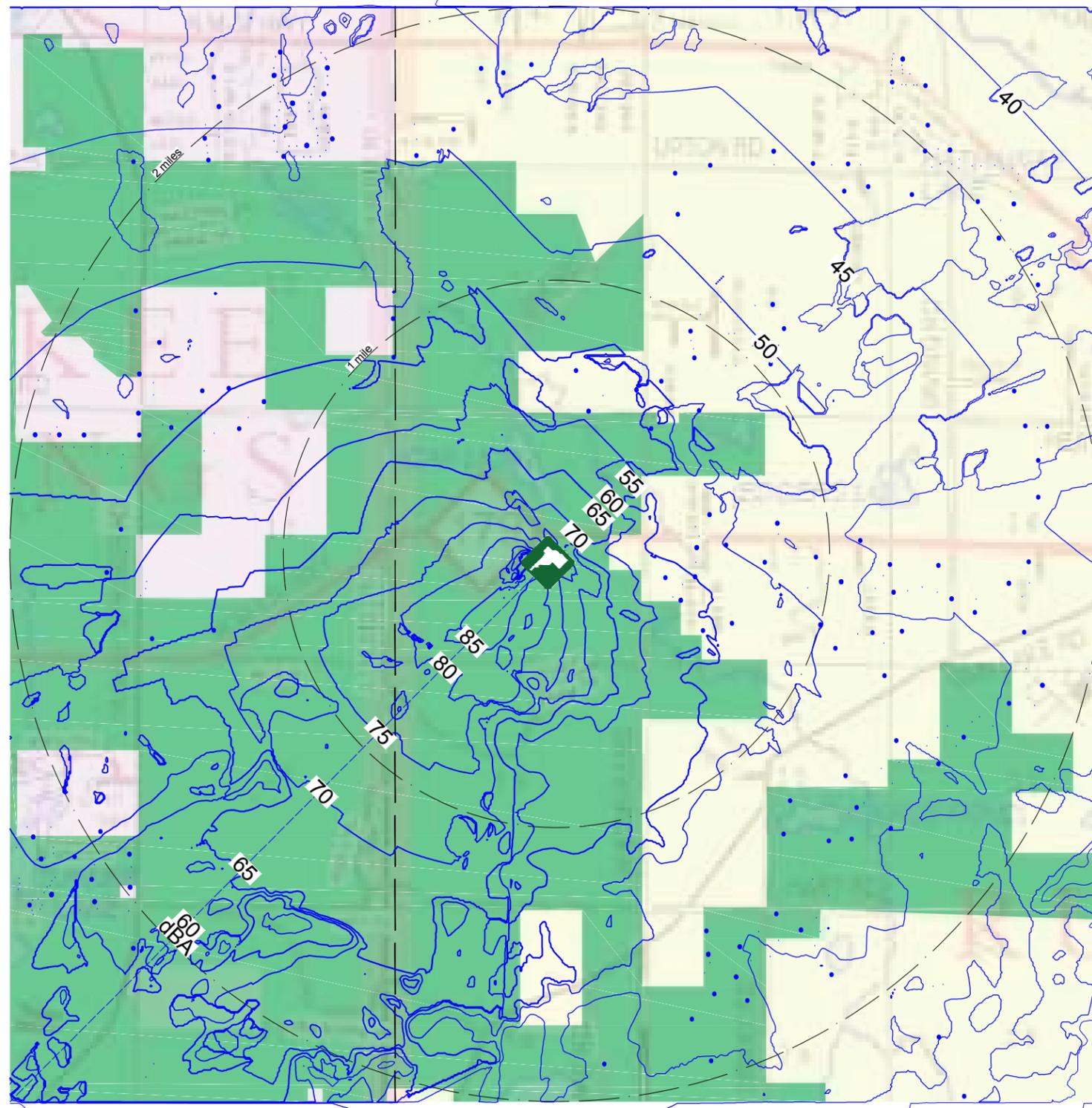
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure N-3



CHIEF NOONDAY

Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

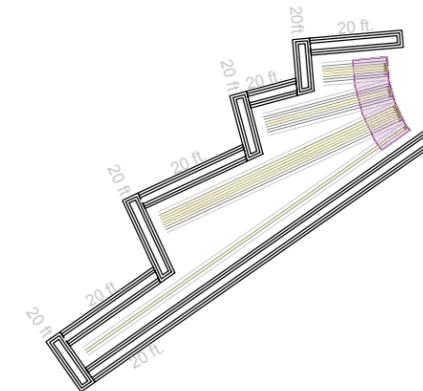
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms

Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure N-4

APPENDIX O: COMPUTER MODEL STUDY 10:

A 40 ft. Deep Extension Added to the Range Structure in the Direction of Fire and a Berm added at the Rear of the Range

Site 1 Alternate Range Orientation; Site 2 Base and Alternate Range Orientation

Typical Day Scenario

20 ft. and 30 ft. tall berm

Computer model study 10 was conducted with a 20 ft and 30 ft. tall berms added on the down range and rear sides of the range in addition to the side and rear walls added to the range structure so the firing positions were open only in the direction of fire; the 40 ft. deep extension added to the roof/ceiling of the range structure with the underside of the roof lined with a sound absorbent panel mounted on plywood; and the lane dividing side, and rear walls covered with the sound absorbent facing used in Computer Model Studies 7, 8 and 9. The models were run on Site 1: Barry State Game Area Existing Range Site with the direction of fire to the east and southwest with the typical day scenario and Site 2: Barry State Game Area Chief Noonday Site with the direction of fire to the south and southwest with the typical day scenario.

1. The “typical day” had 5 shooters firing a .223 caliber rifle on the 100 yard range; 1 shooter firing a .223 caliber rifle on the 150 yard range; 2 shooters firing a 12 gauge Remington shotgun on the 50 yard range; and 3 shooters firing a 0.40 caliber handgun on the 25 yard range within a 1 second time period.
2. The wind condition in the base model was modeled as downwind with 1 to 11 mph wind as in computer model studies 1 and 2.
3. The 50°F and 70% relative humidity condition was used in the models.
4. A 40 ft. deep extension was added to the range structure. The underside of the extension was lined with a sound absorbent material installed over plywood as in Computer Model Study 9.
5. A 30 ft. tall U-shaped berm described in Computer Model Study 6 was also included.
6. The side walls and rear wall of the range structure were also included in this model so that the range was only open in the direction of fire. Wood frame walls were built between each firing lane with plywood covering. Sound absorbent panels were installed on the sides and ceiling of each lane as well as on the side and rear walls of the entire range structure as in Computer Model Studies 7 and 8.
7. The direction of fire was to the east and southwest for Site 1 and to the south and southwest for Site 2.
8. Berm heights of 20 ft. and 30 ft. were used in the reference model.
9. The sound levels shown on the noise contour maps are LA eq in dBA.

In Experiment 10, the down range berm height is raised to 20 ft. and 30 ft. tall along with a U-shaped berm added at the rear of the range in addition to the 40 ft. deep roof lined with sound absorbent material that was constructed on the down range side of the range building in Experiment 9; and the addition of the solid side walls and rear wall added to the range building in Experiment 8; and the solid dividers are installed between each lane at the Site 1: Barry SGA range oriented to the east and to the southwest and at Site 2: Chief Noonday range oriented to the south and to the southwest with the 20 ft. and 30 ft. tall downrange berms and the “typical day” scenario in Experiment 7.

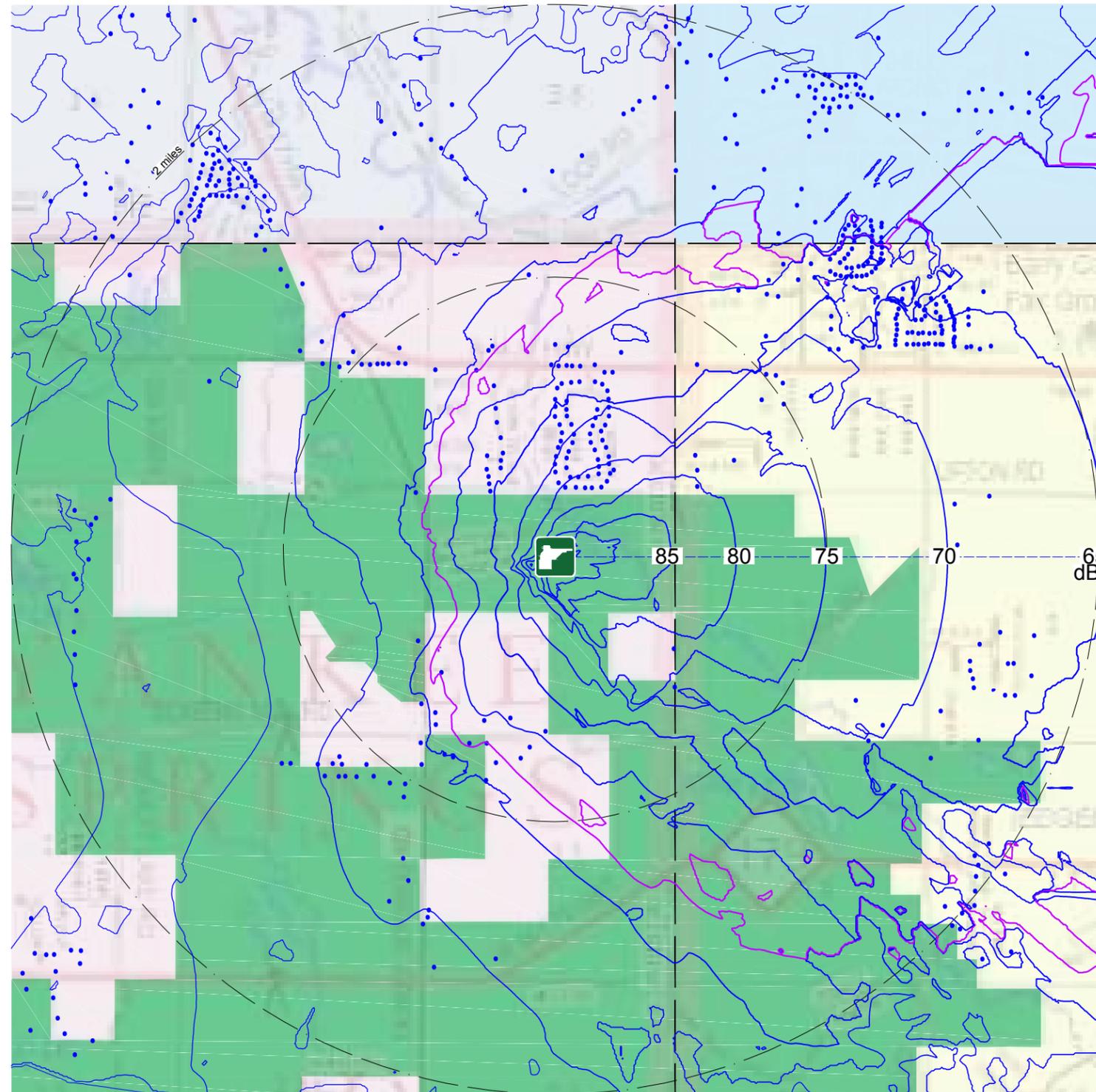
A sound absorbent lining panel is added to the rear wall, side walls, interior lane dividing walls and the ceiling of each lane in the range building. This locates each shooter in a sound absorbent enclosure on 3 sides with a 40 ft. deep roof structure that reduces sound propagating out of the range building.

The linear pressure score is reduced by approximately 95% for the Site 2: Chief Noonday range oriented to the southwest with 30 ft. tall berms and by 91% when the range is oriented to the south with 30 ft. tall berms. The linear pressure score is reduced by approximately 86% for the Site 1: Barry SGA range oriented to the southwest with 30 ft. tall berms and by 79% when the range is oriented to the southwest with 20 ft. tall berms.

The rough order of magnitude cost for installing the 40 ft. extension of the roof, the side walls, rear wall, solid dividers in each of the lanes and lining the ceiling and walls of each lane with a weather-resistant sound absorbing panel such as Troy Board manufactured by Troy Acoustics is \$820,500 including 20 ft. tall berms on all four sides of the range and \$1,640,200 with 30 ft. tall berms on all four sides of the range

Table O-1. Summary table of rating points for each scenario tested in Experiment 10.

TYPICAL DAY 11 SHOOTERS U-SHAPED BERM AT REAR OF RANGE EXTENDED ROOF STRUCTURE					
Site	DOF	Berm Height	Lin Press	dB	PTS
SITE 2: Chief Noonday	SW	30 FT. U-Shaped Berm	500	77	1695
SITE 2: Chief Noonday	S	30 FT. U-Shaped Berm	872	79	1694
SITE 2: Chief Noonday	SW	20 FT. U-Shaped Berm	979	80	1954
SITE 2: Chief Noonday	S	20 FT. U-Shaped Berm	1,247	81	1558
SITE 2: Chief Noonday Reference	S	20 FT. Tall Berm	4,630	87	1785
SITE 1: Barry SGA	SW	30 FT. U-Shaped Berm	9,676	90	163
SITE 1: Barry SGA	SW	20 FT. U-Shaped Berm	14,919	92	2439
SITE 1: Barry SGA	E	30 FT. U-Shaped Berm	15,328	92	316
SITE 1: Barry SGA	E	20 FT. U-Shaped Berm	25,914	94	435
SITE 1: Barry SGA Reference	E	20 FT. Tall Berm	59,135	98	2140



BARRY SGA

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear +
 Side Walls

Shooters within 1 second:

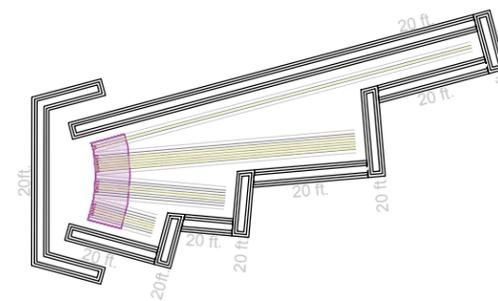
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. East

20 ft. End Berms
 20 ft. Side Berms
 20 ft. U-Shaped Berm

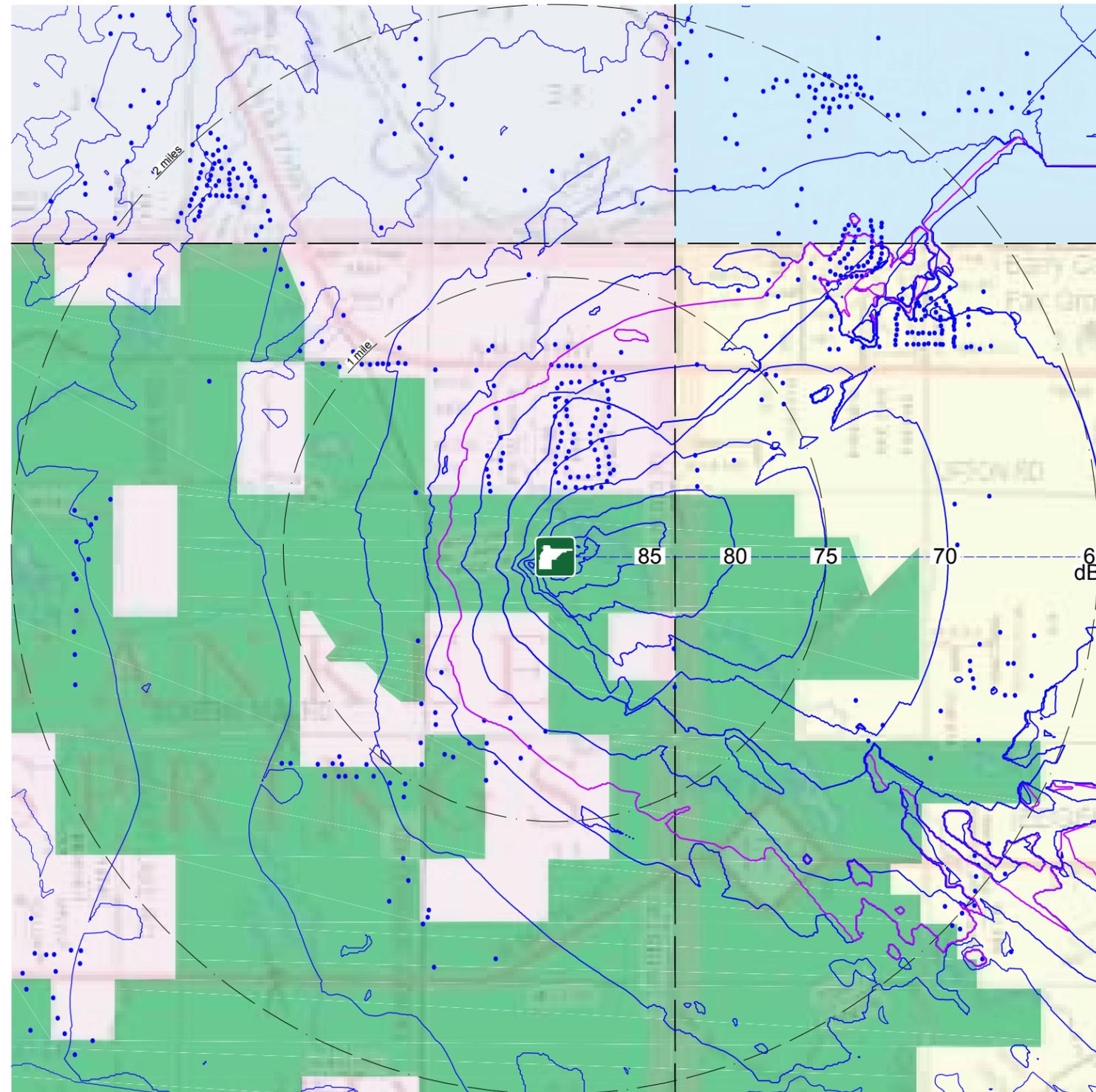
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
 - THORNAPPLE TOWNSHIP
No sound level limitations established
 - YANKEE SPRINGS TOWNSHIP
No sound level limitations established
 - IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
 - RUTLAND TOWNSHIP
No sound level limitations established
 - 57 dBA Residential Zones
 - 60 dBA Commercial
 - 65 dBA Industrial
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure O-1



BARRY SGA

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear +
 Side Walls

Shooters within 1 second:

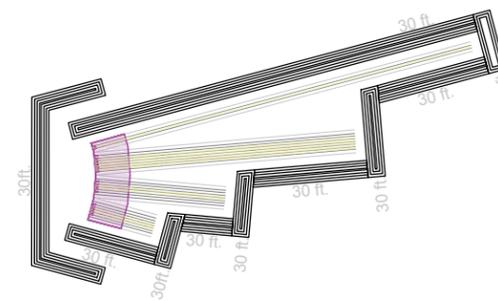
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. East

30 ft. End Berms
 30 ft. Side Berms
 30 ft. U-Shaped Berm

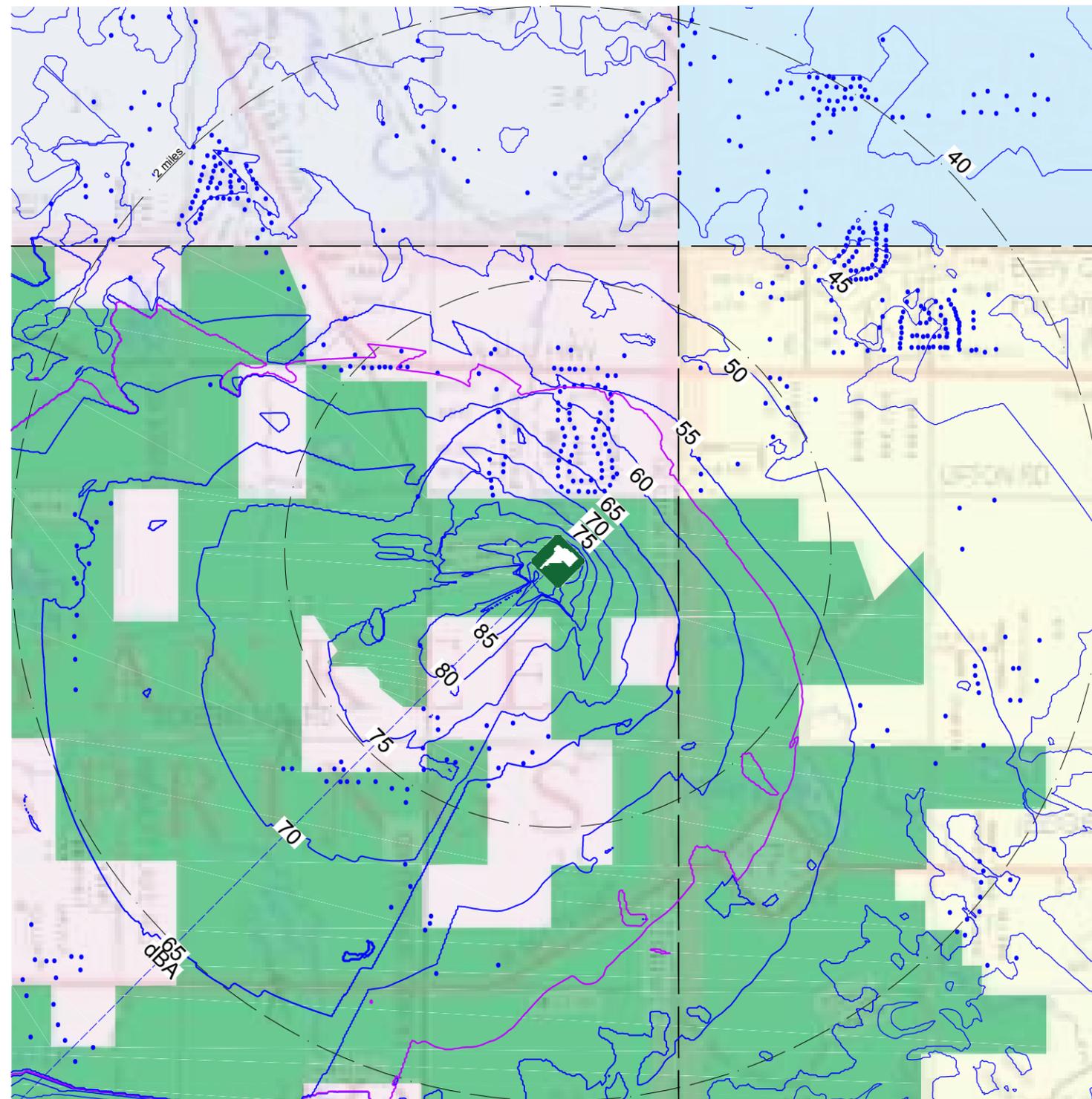
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- THORNAPPLE TOWNSHIP
No sound level limitations established
- IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
- 57 dBA Residential Zones
- 60 dBA Commercial
- 65 dBA Industrial
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure O-2



BARRY SGA

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

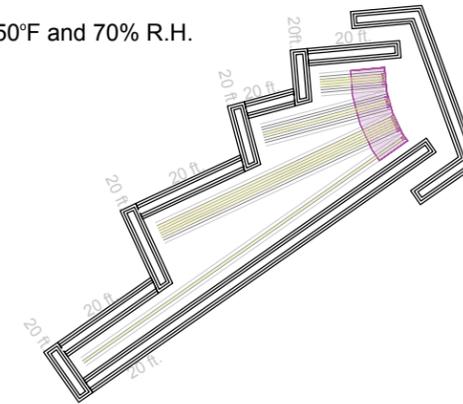
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms
 20 ft. U-Shaped Berm

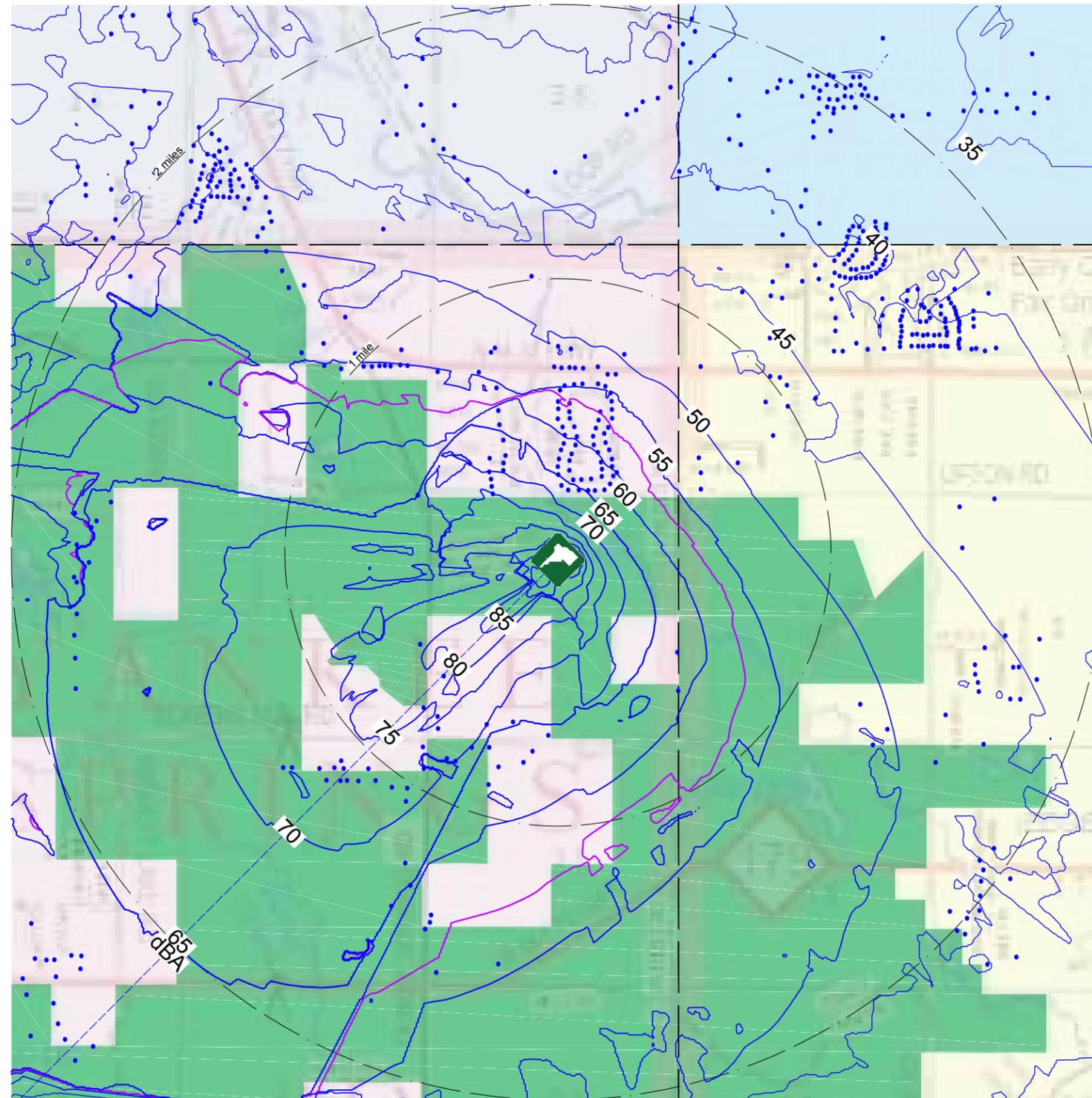
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- THORNAPPLE TOWNSHIP
No sound level limitations established
- IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
- 57 dBA Residential Zones
- 60 dBA Commercial
- 65 dBA Industrial
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure O-3



BARRY SGA

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

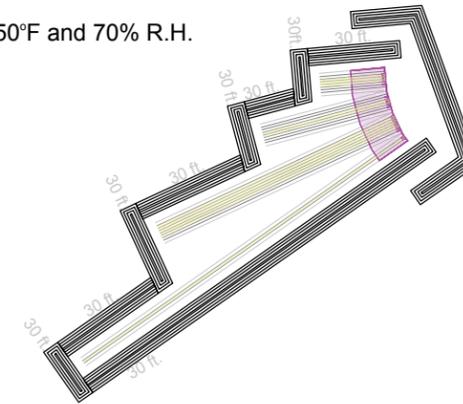
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

30 ft. End Berms
 30 ft. Side Berms
 30 ft. U-Shaped Berm

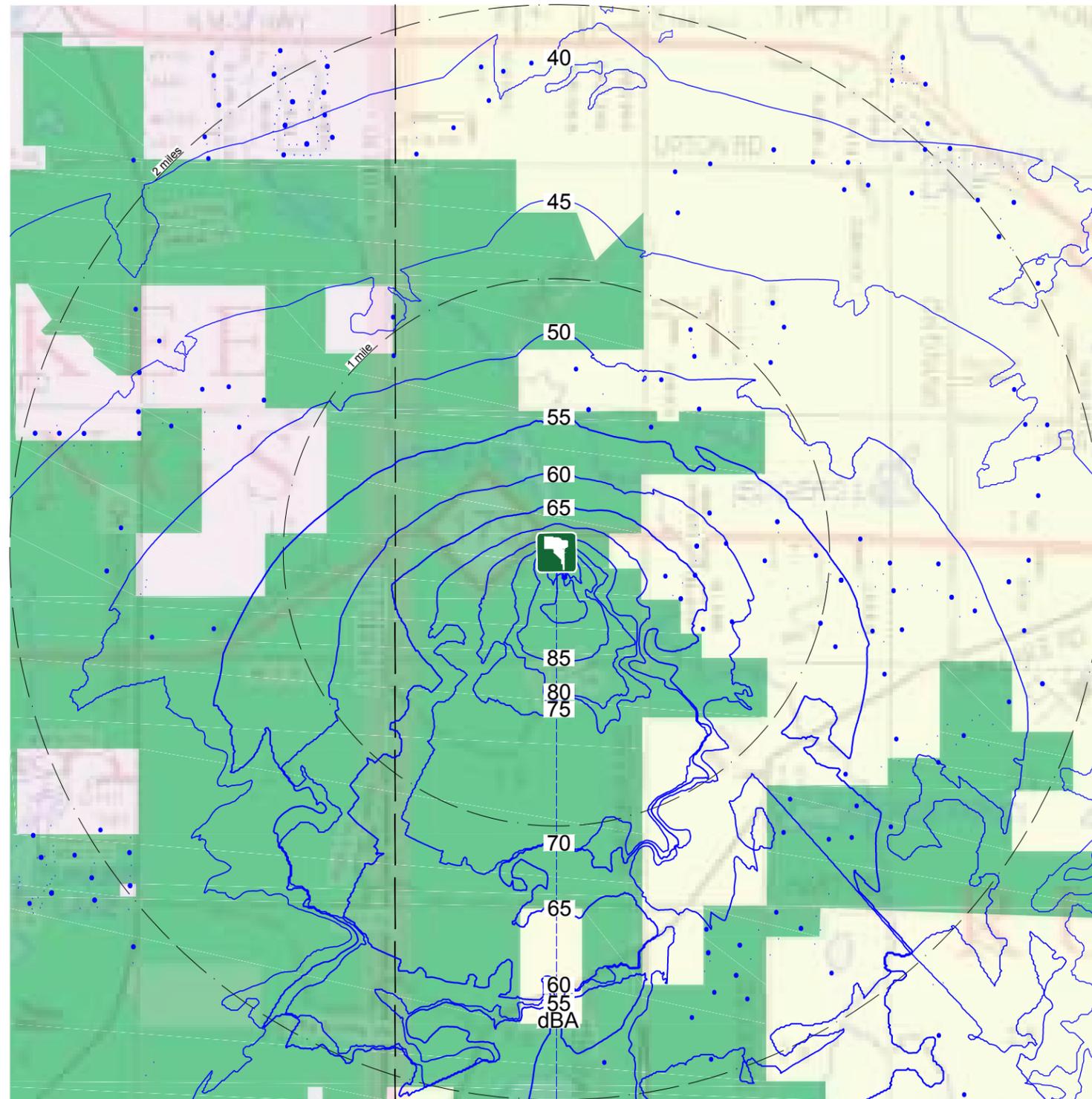
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- THORNAPPLE TOWNSHIP
No sound level limitations established
- IRVING TOWNSHIP
Refer to Barry County Zoning Ordinance
- 57 dBA Residential Zones
- 60 dBA Commercial
- 65 dBA Industrial
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established
- BARRY COUNTY ZONING ORDINANCE
Sound Level Limitations if site is zoned as Commercial

Figure O-3



CHIEF NOONDAY

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear +
 Side Walls

Shooters within 1 second:

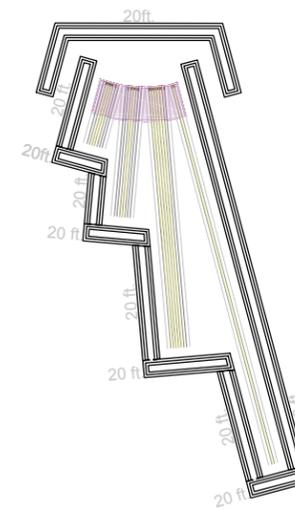
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. South

20 ft. End Berms
 20 ft. Side Berms
 20 ft. U-Shaped Berm

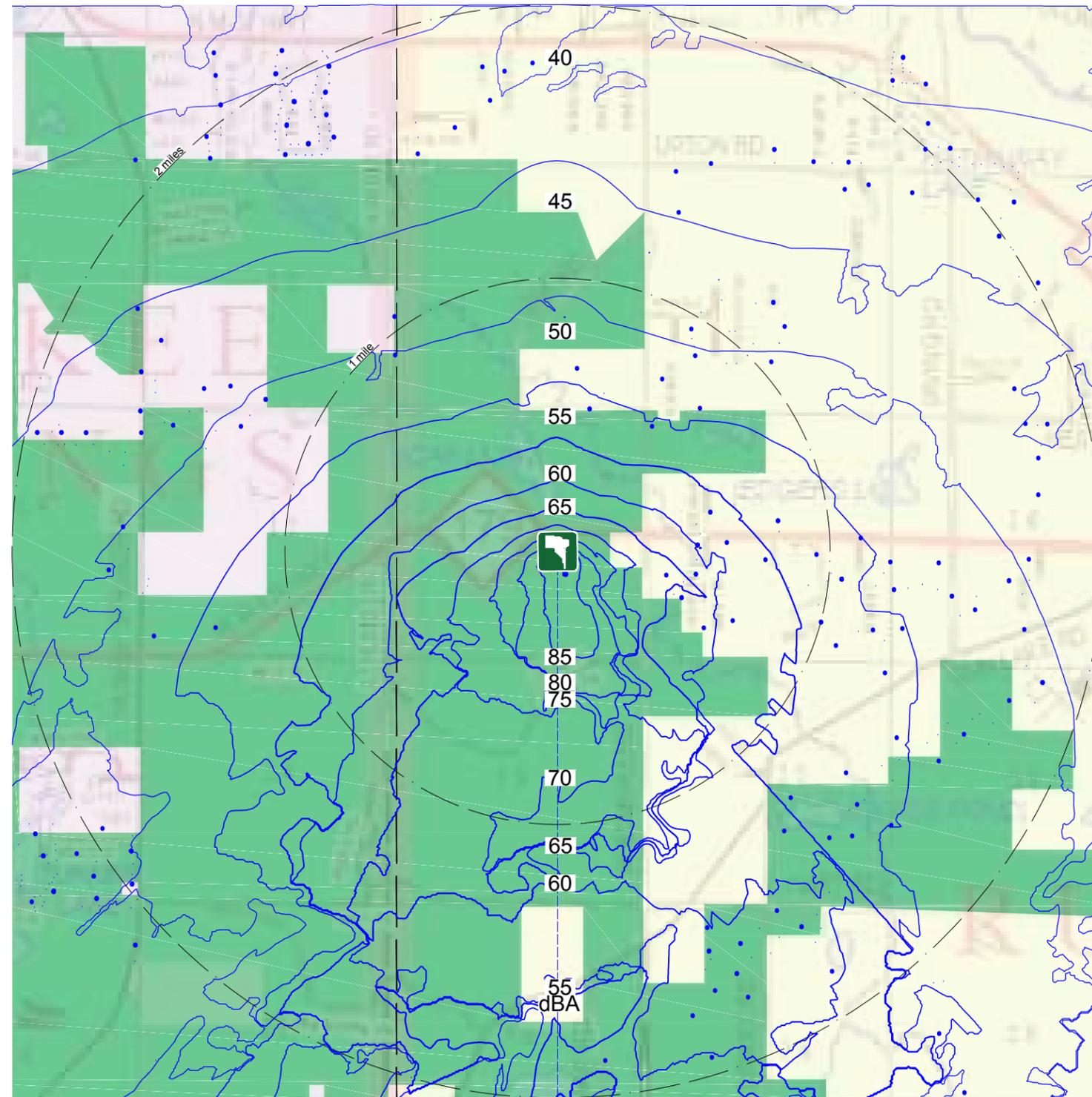
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure O-5



CHIEF NOONDAY

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear +
 Side Walls

Shooters within 1 second:

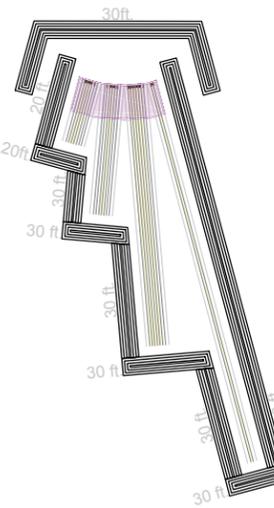
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. South

30 ft. End Berms
 30 ft. Side Berms
 30 ft. U-Shaped Berm

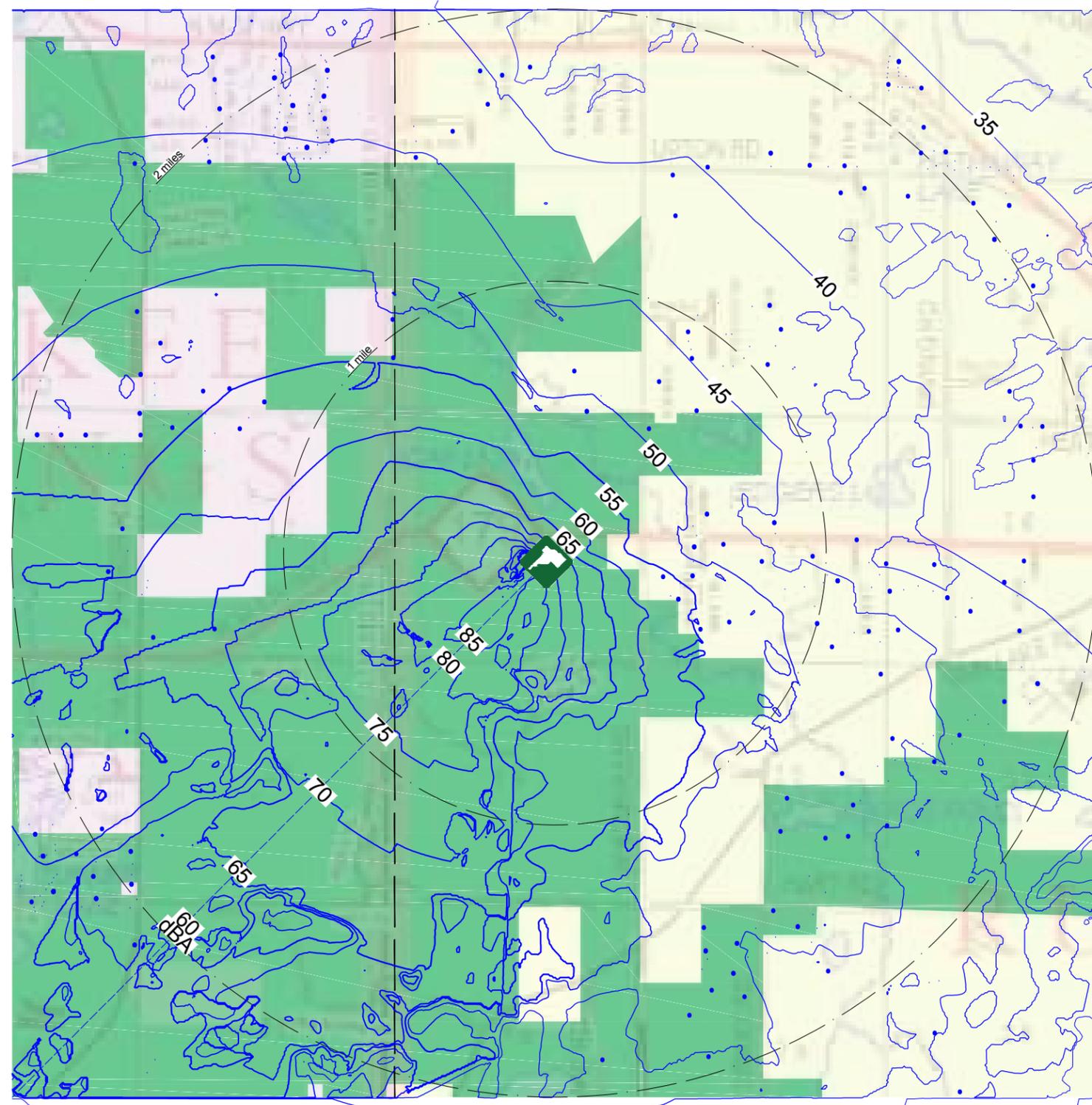
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure O-6



CHIEF NOONDAY

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear +
 Side Walls

Shooters within 1 second:

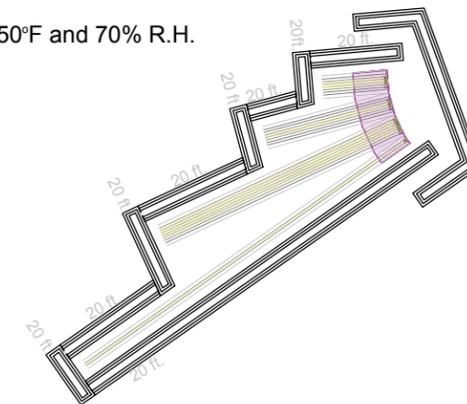
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

20 ft. End Berms
 20 ft. Side Berms
 20 ft. U-Shaped Berm

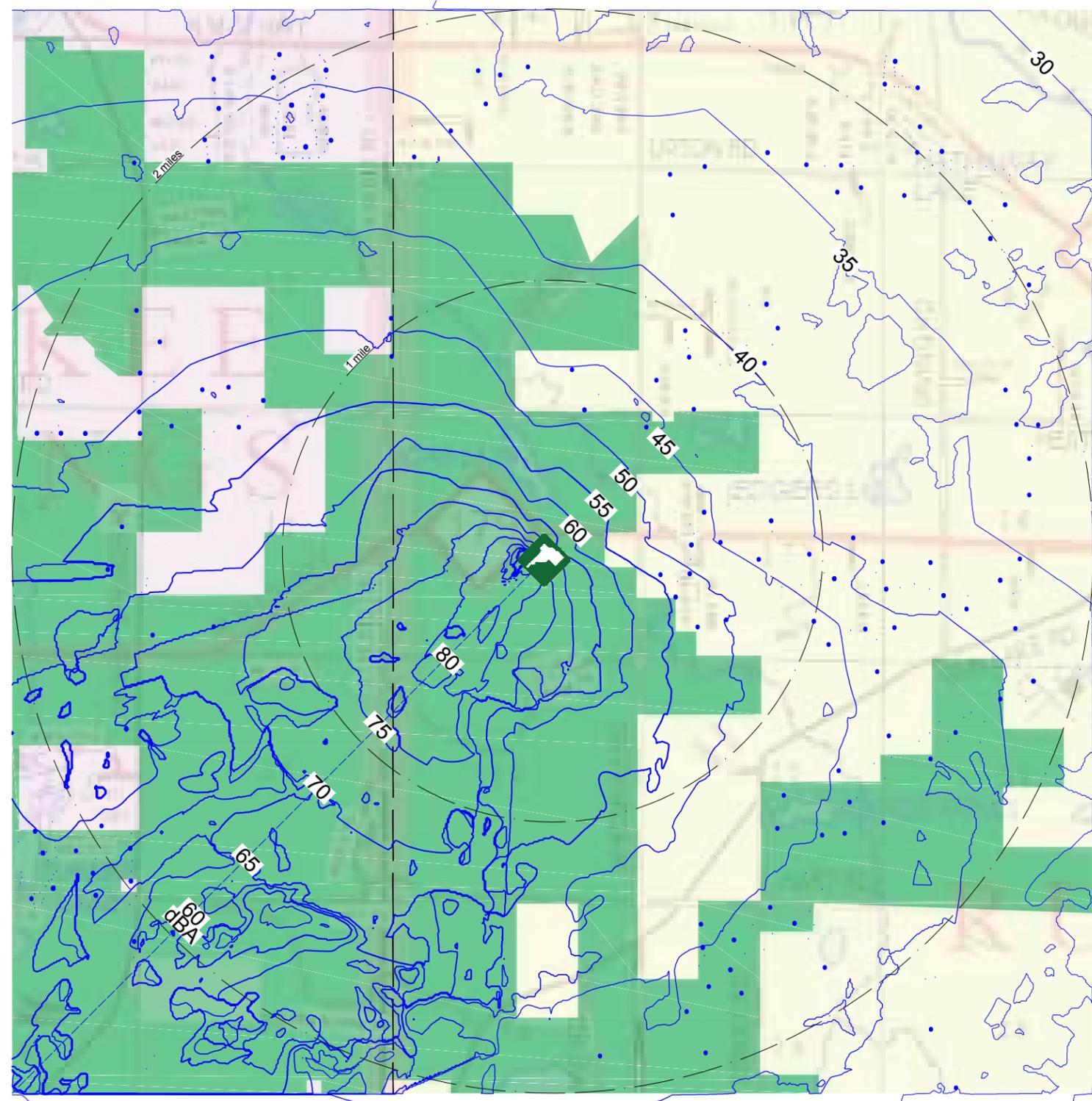
Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure O-7



CHIEF NOONDAY

U-Shaped Berm
 Sound Absorbing 40 ft. Canopy, Dividers, Rear + Side Walls

Shooters within 1 second:

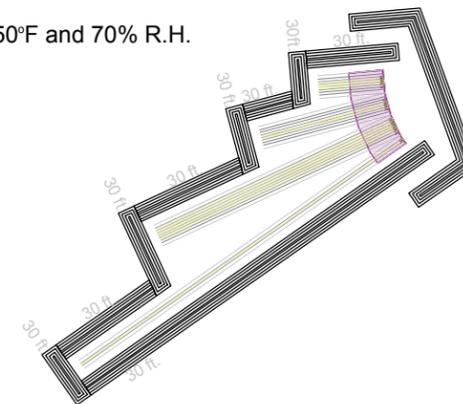
- 6 Rifles
- 2 Shotguns
- 3 Handguns

D.O.F. SW

30 ft. End Berms
 30 ft. Side Berms
 30 ft. U-Shaped Berm

Wind: 1 to 11 mph downward

50°F and 70% R.H.



- STATE GAME AREA
- YANKEE SPRINGS TOWNSHIP
No sound level limitations established
- RUTLAND TOWNSHIP
No sound level limitations established

Figure O-8

APPENDIX P: SUMMARY OF WEATHER CONDITIONS DURING THE FIELD MESAUREMENTS

Table P-1. Summary table of weather conditions at locations near each of the 3 proposed range sites during the field measurements.

Location	Time	Temperature (°F)	Barometric Pressure (inches of mercury)	Relative Humidity %	Wind Speed (mph)
KGRR 9/27/16	Daily Avg.	64	28.87	49%	12 sw
Site 2 9/27/16	2:09 pm	69	28.86	47%	1.5 to 2.8
Site 2 9/27/16	2:31 pm	71	28.86	48%	1 to 2.5
Site 2 9/27/16	3:28 pm	69	28.85	43%	0

APPENDIX Q: LIST OF GPS LOCATIONS FOR THE MEASUREMENT LOCATIONS OF THE EXISTING AMBIENT SOUND LEVELS AND THE SOUNDS OF FIREARMS EXPERIMENTS

Table Q-1. List of GPS coordinates for the locations where measurements of the existing ambient sound levels and sounds of firearms were measured during the field studies.

Receiver Location	North Coordinate	West Coordinate	Elevation
Site 1: Barry State Game Area Existing Range			
1B	N42° 40.130'	W85° 26.292'	760 ft.
3B	N42° 39.838'	W85° 26.014'	760 ft.
4B	N42° 39.787'	W85° 26.540'	780 ft.
5B	N42° 40.022'	W85° 26.552'	770 ft.
6B	N42° 40.347'	W85° 26.318'	750 ft.
7B	N42° 39.851'	W85° 25.715'	770 ft.
8B	N42° 39.504'	W85° 26.090'	780 ft.
9B	N42° 39.732'	W85° 26.813'	765 ft.
10B1	N42° 40.224'	W85° 25.352'	751 ft.
11B	N42° 39.189'	W85° 25.634'	790 ft.
12B	N42° 39.131'	W85° 26.819'	770 ft.
13B	N42° 40.022'	W85° 27.466'	760 ft.
16B	N42° 40.063'	W85° 23.952'	800 ft.
17B	N42° 38.216'	W85° 26.816'	830 ft.
18B	N42° 39.950'	W85° 28.653'	750 ft.
19B	N42° 41.608'	W85° 26.815'	810 ft.
Site 2: Chief Nooday Range Site			
1P	N42° 38.855'	W85° 25.632'	853 ft.
2P ALT	N42° 38.798'	W85° 25.166'	828 ft.
3P	N42° 38.500'	W85° 25.634'	831 ft.
4P ALT	N42° 38.712'	W85° 25.757'	793 ft.
5P	N42° 39.094'	W85° 25.633'	830 ft.
6P1	N42° 38.823'	W85° 24.813'	814 ft.
7P	N42° 38.261'	W85° 25.630'	842 ft.
8P1	N42° 38.512'	W85° 25.970'	789 ft.
9P	N42° 39.552'	W85° 25.633'	822 ft.
10P1	N42° 39.095'	W85° 24.413'	824 ft.
11P	N42° 37.819'	W85° 25.706'	903 ft.

Receiver Location	North Coordinate	West Coordinate	Elevation
12P	N42° 38.869'	W85° 26.641'	789 ft.
13P	N42° 40.420'	W85° 25.637'	823 ft.
14P1 ALT	N42° 38.839'	W85° 23.372'	835 ft.
15P	N42° 36.957'	W85° 25.150'	850 ft.
16P1	N42° 38.359'	W85° 27.821'	815 ft.

**APPENDIX R: CONCEPT COST ESTIMATES FOR NOISE MITIGATION
OPTIONS FOR THE RANGES**

CONCEPTUAL COST REPORT

Project: **Michigan Dept of Natural Resources - Firing Range**
Date: September 15, 2017
Scope of Work: Acoustical Mitigation Systems & Materials for a Shooting Range

#17-646

The following is a conceptual cost estimate for budgetary purposes for the installation of various options for acoustical mitigation at three shooting ranges in Michigan. The locations are Marquette (in the upper peninsula), Allegan (near Kalamazoo), and Lapeer (near Flint).

Please note that these costs are for comparison purposes only and do not represent a detailed cost estimate, as such these costs include a contingency to account for differences in interpretation of the actual scope of work. The costs below have been rounded to the nearest hundred dollars for the sake of simplicity.

Option #1a – Apply acoustic absorbing boards and wool insulation to the underside of the roof over the shooters.

Cost for Marquette = **\$55,400**
Cost for Allegan = **\$55,800**
Cost for Lapeer = **\$56,000**

This cost assumes that the roof structure is existing or provided by others, although the cost of providing the required blocking for installation of the boards is included. The area of the structure is assumed to be 20' deep x 200' long based on preliminary sketches of the range. The cost includes a waste factor for the installation of the boards and includes installing wool between the rafters above the boards.

Option #1b – Construct side walls separating each shooting lane.

Cost for Marquette = **\$29,900**
Cost for Allegan = **\$30,100**
Cost for Lapeer = **\$31,800**

This cost includes construction of wood framed walls with Troy acoustic absorbing boards over (2) layers of plywood sheathing on both sides, and the cavity filled with Troy acoustic wool. The walls are assumed to be 8' High x 6' Long. This cost assumes that a suitable floor and roof exists to brace the walls.

Option #1c – Construct a wall enclosing the rear of the range.

Cost for Marquette = **\$48,200**
Cost for Allegan = **\$48,600**
Cost for Lapeer = **\$51,300**

This cost includes construction of wood framed walls with Troy acoustic absorbing boards over (2) layers of plywood sheathing on the interior side, and fiber cement siding (HardiePlank or similar) over (1) layer plywood sheathing on the exterior, and the cavity filled with Troy acoustic wool. The wall is assumed to be 8' High x 200' Long. This cost assumes that a suitable floor and roof exists to brace the wall.

Option #1d – Construct a roof extension over the shooters with the acoustic absorbing boards and wool insulation applied to the underside.

Cost for Marquette = **\$307,100**
Cost for Allegan = **\$309,600**
Cost for Lapeer = **\$326,800**

This cost includes construction of a wood framed roof structure with a simple metal roof (this is not an architectural grade standing seam roof). The area of the structure is calculated as 40' deep x 200' long. The cost includes acoustical boards and wool as described above. No floor or walls are included in the cost.

Option #2a – Construct a 10' high berm on 3 sides of the range.

Cost for Marquette = **\$81,900**
Cost for Allegan = **\$82,600**
Cost for Lapeer = **\$87,200**

Option #2b – Construct a 20' high berm on 3 sides of the range.

Cost for Marquette = **\$315,800**
Cost for Allegan = **\$318,300**
Cost for Lapeer = **\$336,000**

Option #2c – Construct a 30' high berm on 3 sides of the range.

Cost for Marquette = **\$752,800**
Cost for Allegan = **\$758,800**
Cost for Lapeer = **\$801,000**

This cost for Options 2a, 2b, & 2c assumes a slope of 1/1.5 for the berms and lengths based on preliminary sketches of the range. This cost assumes all imported fill to build up the berm, if local soils (that is, within 500 feet of the range) are available, \$3 per cubic yard can be deducted from the cost indicated. It should also be noted that maintaining the same slope for the higher berms results in longer as well as higher berms and some cost can be reduced by allowing for a steeper slope as the berm increases in height. The maximum slope that can be achieved depends on the type of soils used in the berm and the 1/1.5 slope is a safe assumption at a conceptual stage.

Option #3a – Construct a 10' high berm on the 4th side of the range, for a fully enclosed range.

Cost for Marquette = **\$32,600**
Cost for Allegan = **\$32,900**
Cost for Lapeer = **\$34,700**

Option #3b – Construct a 20' high berm on the 4th side of the range, for a fully enclosed range.

Cost for Marquette = **\$113,000**
Cost for Allegan = **\$113,900**
Cost for Lapeer = **\$120,300**

Option #3c – Construct a 30' high berm on the 4th side of the range, for a fully enclosed range.

Cost for Marquette = **\$489,200**

Cost for Allegan = **\$493,100**

Cost for Lapeer = **\$520,500**

This cost for Options 3a, 3b, & 3c includes the same assumptions and qualifications as indicated for Option 2a, b, c. The configuration of this berm allowed for the passage of people between the berms at the entrance end of the range with an overlap of the berms as indicated in the conceptual sketches.

Attached are the following backup documents: a spreadsheet with a more detailed breakdown of costs, sketches used in calculating quantities of materials.

Please do not hesitate to call if you have any questions or need a clarification on anything in this report.

Prepared by:



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Architect / Project Manager
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Conceptual Cost Estimate **#17-646**

Project: Michigan Dept of Natural Resources - Firing Range
Description of Work: Acoustical Mitigation Systems & Materials for a Shooting Range September 15, 2017

ITEM	QTY	UNIT	U/L	LABOR	U/M	MATERIAL	Burden + OHP	TOTAL
Apply Acoustic Treatment to Underside of Roof								
Troy Boards Installed @ Ceiling of Range Roof	4,400	SF	1.18	\$ 5,211.80	8.19	\$ 36,052.72	\$ 9,322.88	\$ 50,587.40
Additional Wood Blocking	1,680	LF	1.31	\$ 2,200.80	0.41	\$ 688.80	\$ 1,611.15	\$ 4,500.75
Screws, Nails, & Connectors	1	LS	74.13	\$ 74.13	183.71	\$ 183.71	\$ 79.95	\$ 337.78

Note: Structure by others. Assumed 20' x 200' roof area over shooters + waste factor. Includes wool insulation between rafters.

TOTAL COST CALCULATED FOR MARQUETTE = \$ 55,425.94
TOTAL COST ADJUSTED FOR ALLEGAN = \$ 55,869.34
TOTAL COST ADJUSTED FOR LAPEER = \$ 58,973.20

Add Side Walls Between Shooters w/ Acoustic Treatment

2x4 Wood Framed Side Walls	1,232	LF	1.53	\$ 1,882.08	1.51	\$ 1,861.72	\$ 1,581.45	\$ 5,325.25
3/4" CDX Plywood Sheathing	4,224	SF	0.76	\$ 3,206.02	1.11	\$ 4,671.76	\$ 2,933.98	\$ 10,811.76
Connectors, Hangers, Nails, Etc.	1	LS	508.81	\$ 508.81	653.35	\$ 653.35	\$ 451.54	\$ 1,613.70
Troy Boards & Wool Fill	1,056	SF	1.18	\$ 1,250.83	8.19	\$ 8,652.65	\$ 2,237.49	\$ 12,140.98

Note: Assumed 8'H x 6'W walls, (2) layers of plywood w/ (1) layer Troy Board

TOTAL COST CALCULATED FOR MARQUETTE = \$ 29,891.69
TOTAL COST ADJUSTED FOR ALLEGAN = \$ 30,130.82
TOTAL COST ADJUSTED FOR LAPEER = \$ 31,804.76

Add Wall Enclosing Rear of Range w/ Acoustic Treatment (1 side) & Siding (other side)

2x4 Wood Framed Side Walls	1,232	LF	1.53	\$ 1,882.08	1.51	\$ 1,861.72	\$ 1,581.45	\$ 5,325.25
3/4" CDX Plywood Sheathing	4,800	SF	0.76	\$ 3,643.20	1.11	\$ 5,308.82	\$ 3,334.07	\$ 12,286.09
30# Asphalt Felt	1,600	SF	0.18	\$ 285.60	0.33	\$ 526.61	\$ 279.04	\$ 1,091.24
Cement Fiber Siding	1,600	SF	2.13	\$ 3,404.00	1.96	\$ 3,140.14	\$ 2,823.95	\$ 9,368.10
Connectors, Hangers, Nails, Etc.	1	LS	552.53	\$ 552.53	717.05	\$ 717.05	\$ 491.55	\$ 1,761.13
Troy Boards & Wool Fill	1,600	SF	1.18	\$ 1,895.20	8.19	\$ 13,110.08	\$ 3,390.14	\$ 18,395.42

Note: Assumed 8'H x 200'W wall, (2) layers plywood w/ Troy Board one side, (1) layer plywood w/ siding over felt other side

TOTAL COST CALCULATED FOR MARQUETTE = \$ 48,227.23
TOTAL COST ADJUSTED FOR ALLEGAN = \$ 48,613.05
TOTAL COST ADJUSTED FOR LAPEER = \$ 51,313.78

Conceptual Cost Estimate

#17-646

Project:

Michigan Dept of Natural Resources - Firing Range

Description of Work:

Acoustical Mitigation Systems & Materials for a Shooting Range

September 15, 2017

ITEM	QTY	UNIT	U/L	LABOR	U/M	MATERIAL	Burden + OHP	TOTAL
Extended Roof Structure w/ Acoustic Treatment								
6x6 x 12'L - PT Posts	30	Ea	47.52	\$ 1,425.60	69.30	\$ 2,079.00	\$ 1,304.90	\$ 4,809.50
Concrete Footings (w/ excavation)	5	CY	196.50	\$ 884.25	231.08	\$ 1,039.86	\$ 769.44	\$ 2,693.55
2x12 Wood Beams	800	LF	2.01	\$ 1,610.00	1.70	\$ 1,356.80	\$ 1,315.11	\$ 4,281.91
2x8 Wood Rafters	4,200	LF	1.51	\$ 6,327.30	1.40	\$ 5,876.64	\$ 5,255.48	\$ 17,459.42
2x2 Wood Blocking	3,600	LF	1.51	\$ 5,423.40	0.41	\$ 1,476.00	\$ 3,934.92	\$ 10,834.32
Connectors, Hangers, Nails, Etc.	1	LS	1,567.06	\$ 1,567.06	1,774.25	\$ 1,774.25	\$ 1,352.61	\$ 4,693.91
3/4" CDX Plywood Sheathing	8,000	SF	0.76	\$ 6,072.00	1.11	\$ 8,848.03	\$ 5,556.79	\$ 20,476.82
Metal Roof over Membrane	8,000	SF	4.59	\$ 36,720.00	5.26	\$ 42,060.80	\$ 31,772.77	\$ 110,553.57
Flashing	480	LF	1.90	\$ 913.92	1.25	\$ 597.84	\$ 718.95	\$ 2,230.71
Troy Boards Installed @ Ceiling of Range Roof	8,800	SF	1.18	\$ 10,423.60	8.19	\$ 72,105.44	\$ 18,645.77	\$ 101,174.81
Contingency @ 10%	1	LS						\$ 27,920.85

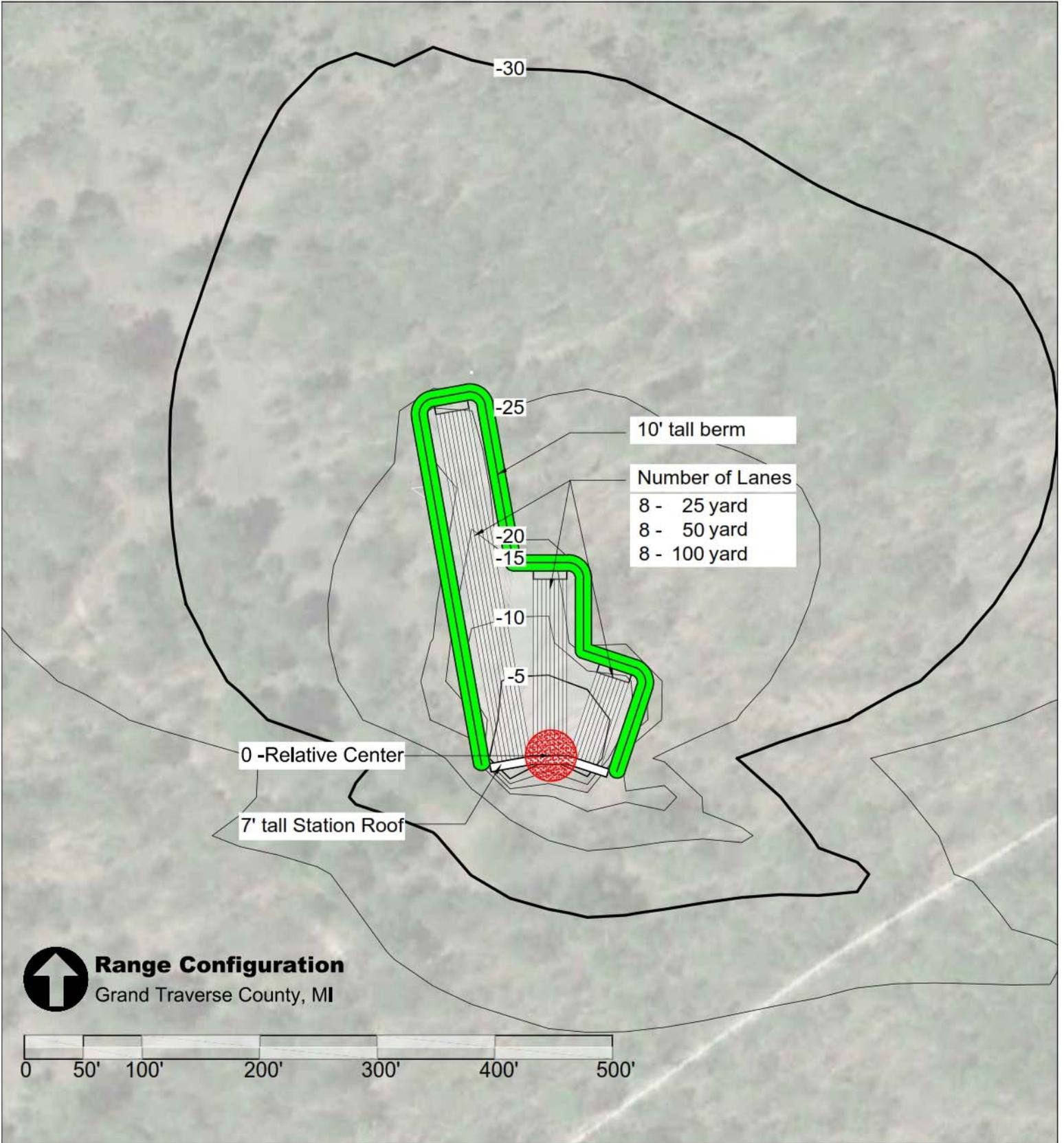
Note: Includes structure. Assumed 40' x 200' extended roof area.

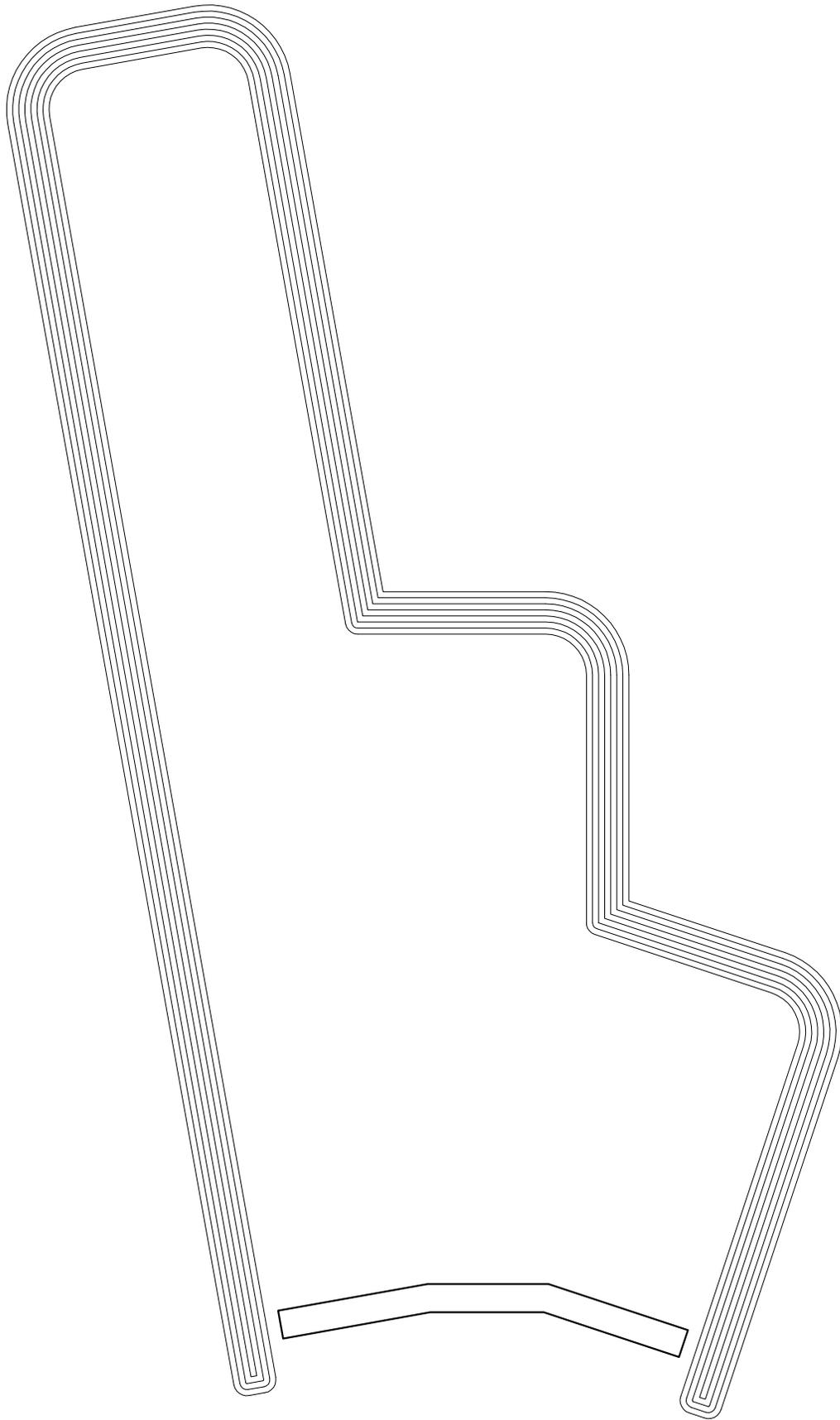
TOTAL COST CALCULATED FOR MARQUETTE = \$ 307,129.36

TOTAL COST ADJUSTED FOR ALLEGAN = \$ 309,586.39

TOTAL COST ADJUSTED FOR LAPEER = \$ 326,785.64

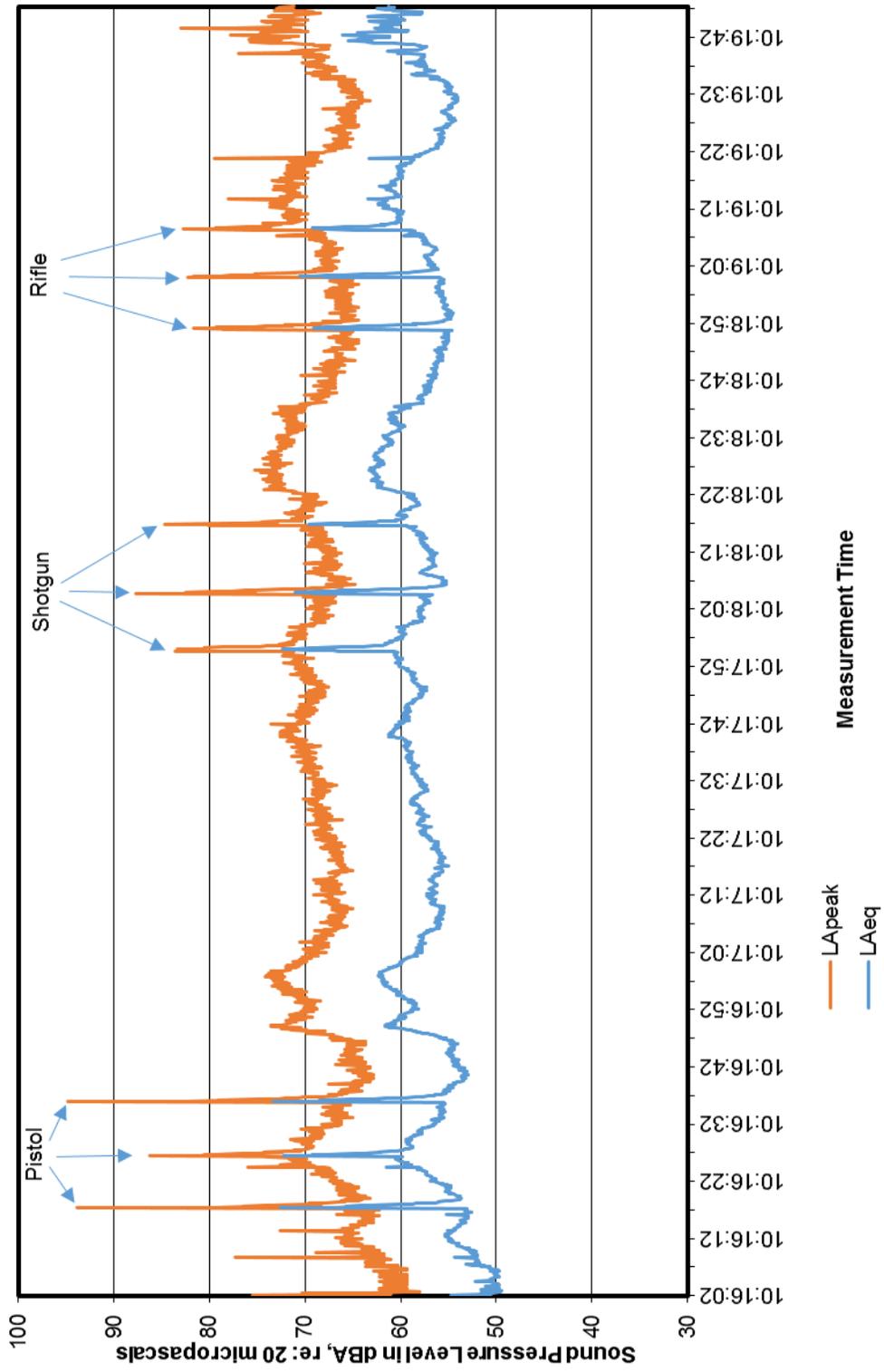
ITEM	QTY	UNIT	UNIT COST	Marquette	Allegan	Lapeer
10' High Berms						
3 sides of range	7,670	CY	\$10.68	\$ 81,937.36	\$ 82,592.86	\$ 87,181.36
4th side of range	3,056	CY	\$10.68	\$ 32,642.52	\$ 32,903.66	\$ 34,731.64
20' High Berms						
3 sides of range	34,147	CY	\$9.25	\$ 315,770.66	\$ 318,296.83	\$ 335,979.99
4th side of range	12,222	CY	\$9.25	\$ 113,023.44	\$ 113,927.63	\$ 120,256.94
30' High Berms						
3 sides of range	84,630	CY	\$8.89	\$ 752,751.81	\$ 758,773.82	\$ 800,927.92
4th side of range	55,000	CY	\$8.89	\$ 489,203.74	\$ 493,117.37	\$ 520,512.78



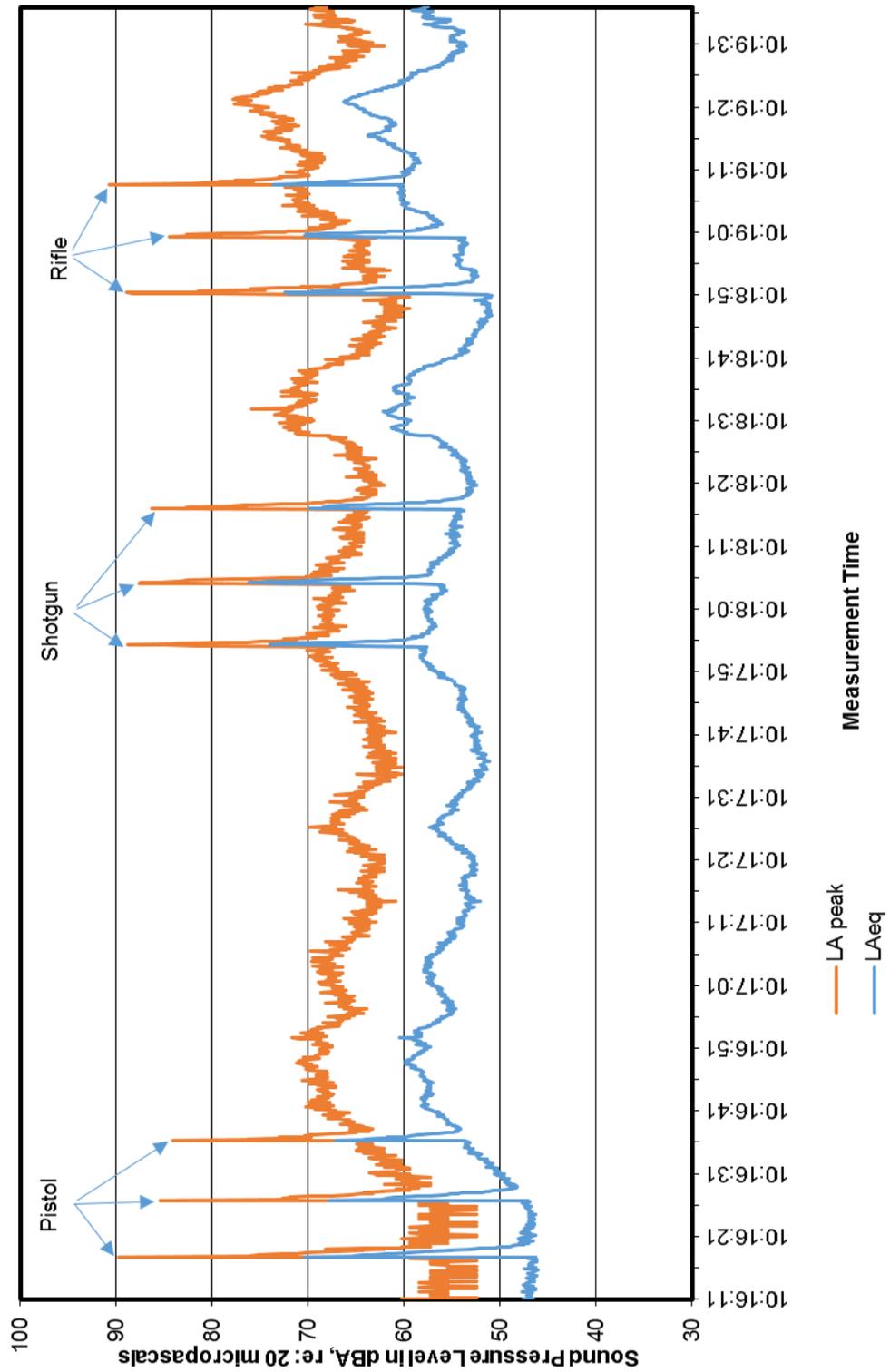


**APPENDIX S: GRAPHS OF AVERAGE AND PEAK SOUND LEVELS MEASURED
DURING THE FIREARMS EXPERIMENTS AT DISTANCES AWAY FROM THE 2
PROPOSED RANGE SITES**

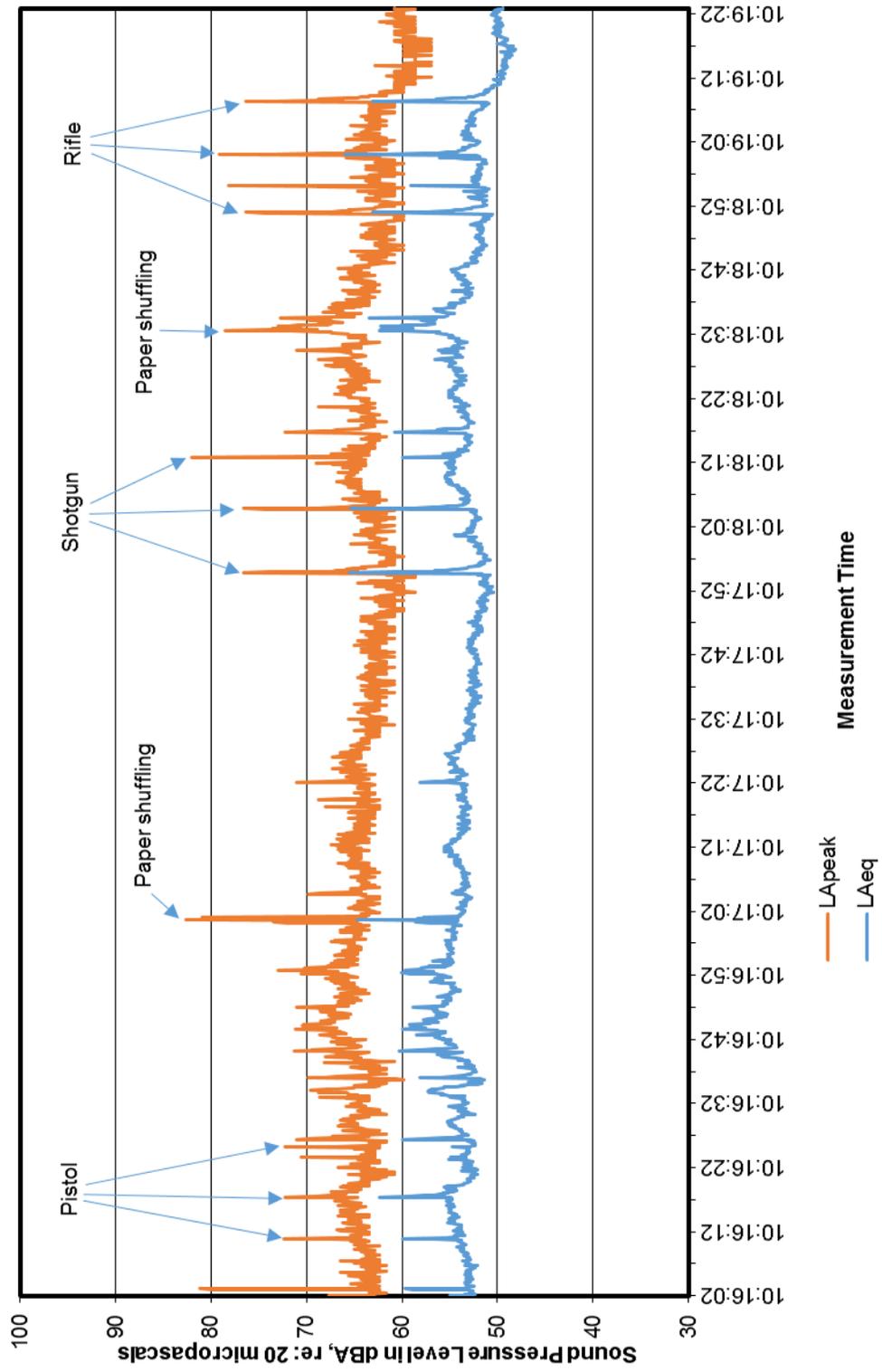
**Michigan DNR 2
Site: Barry
Receiver Location: 1B**



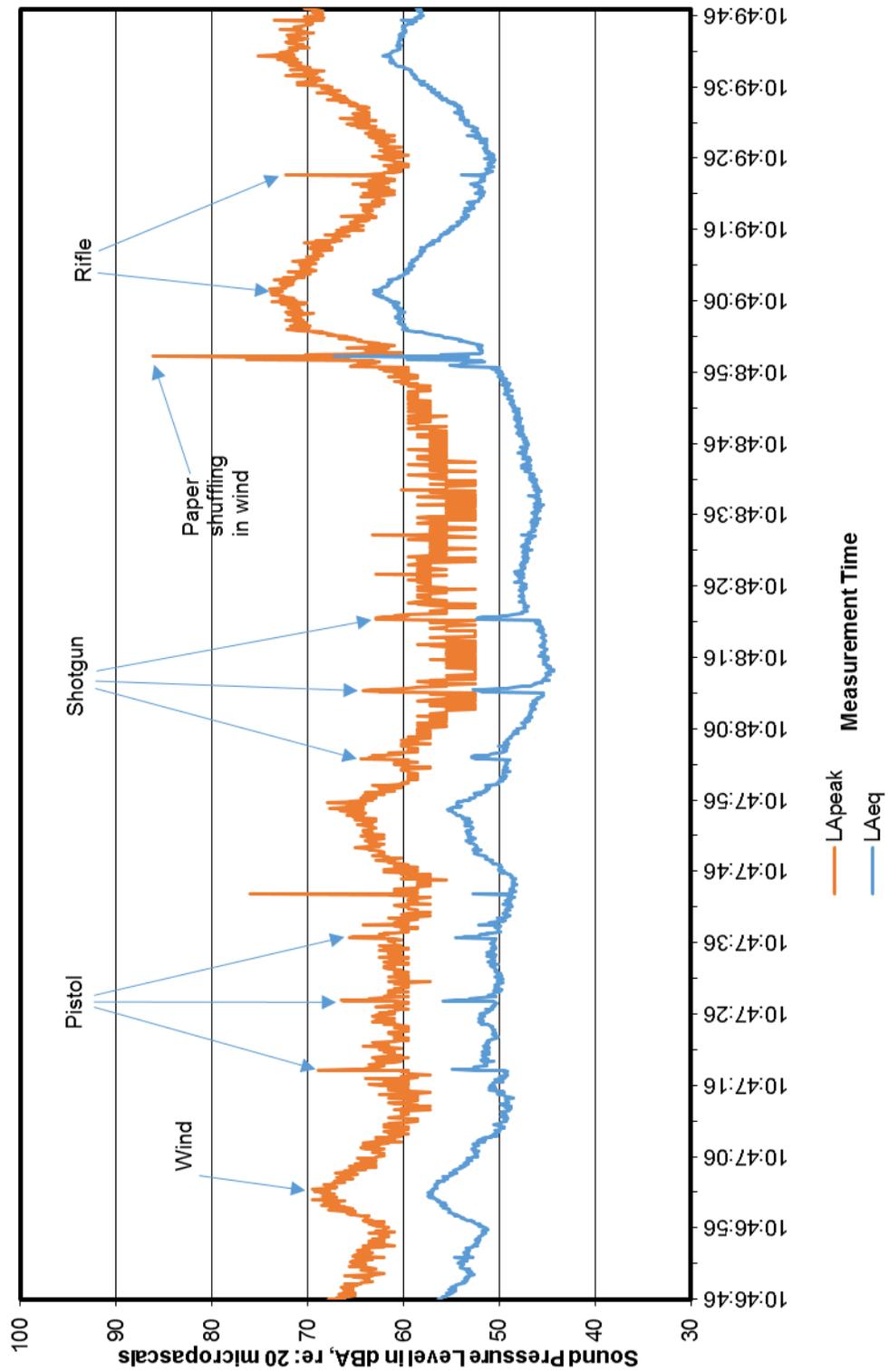
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Receiver Location: 3B**



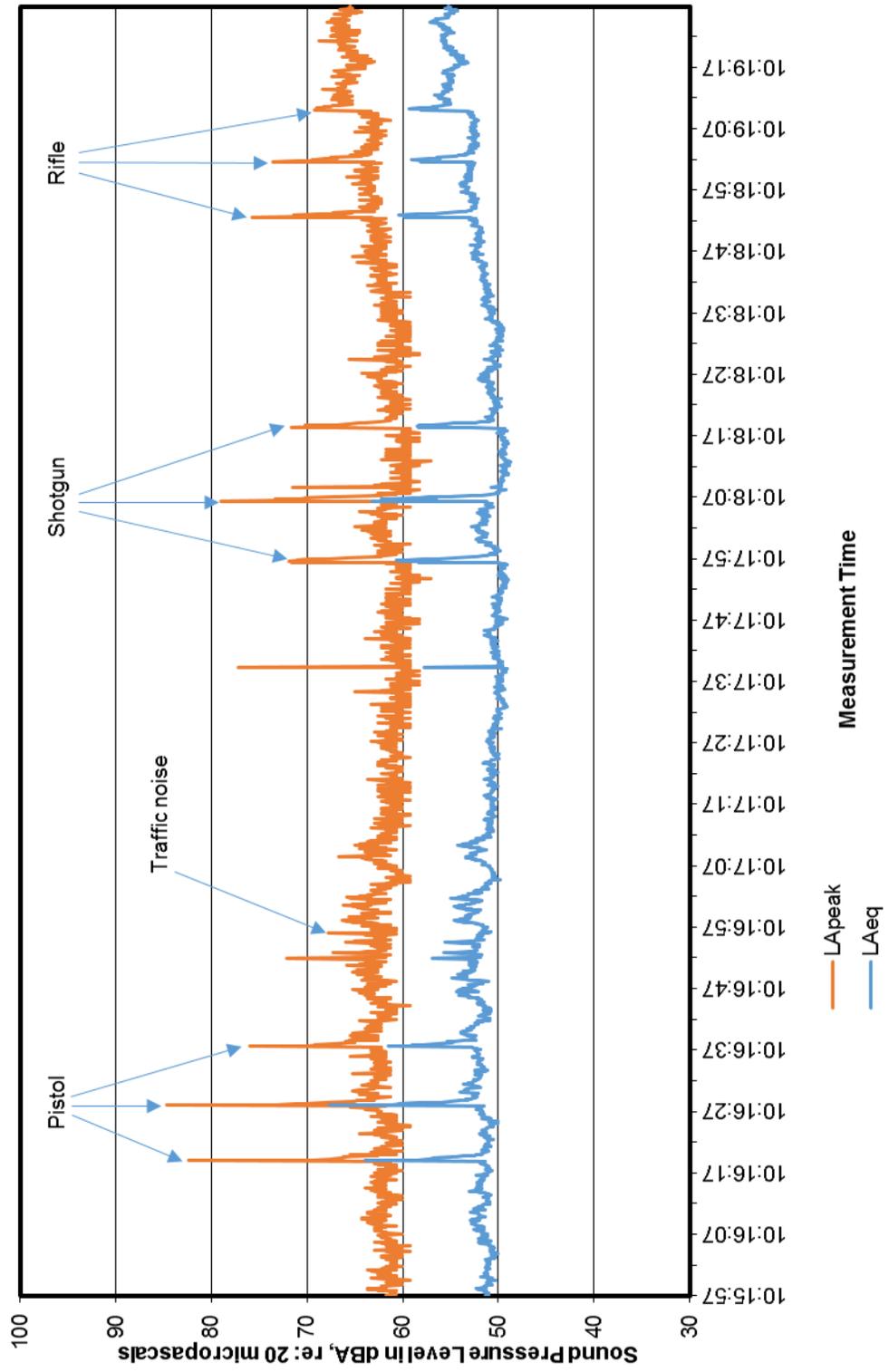
**Michigan DNR 2
Site: Barry
Receiver Location: 4B**



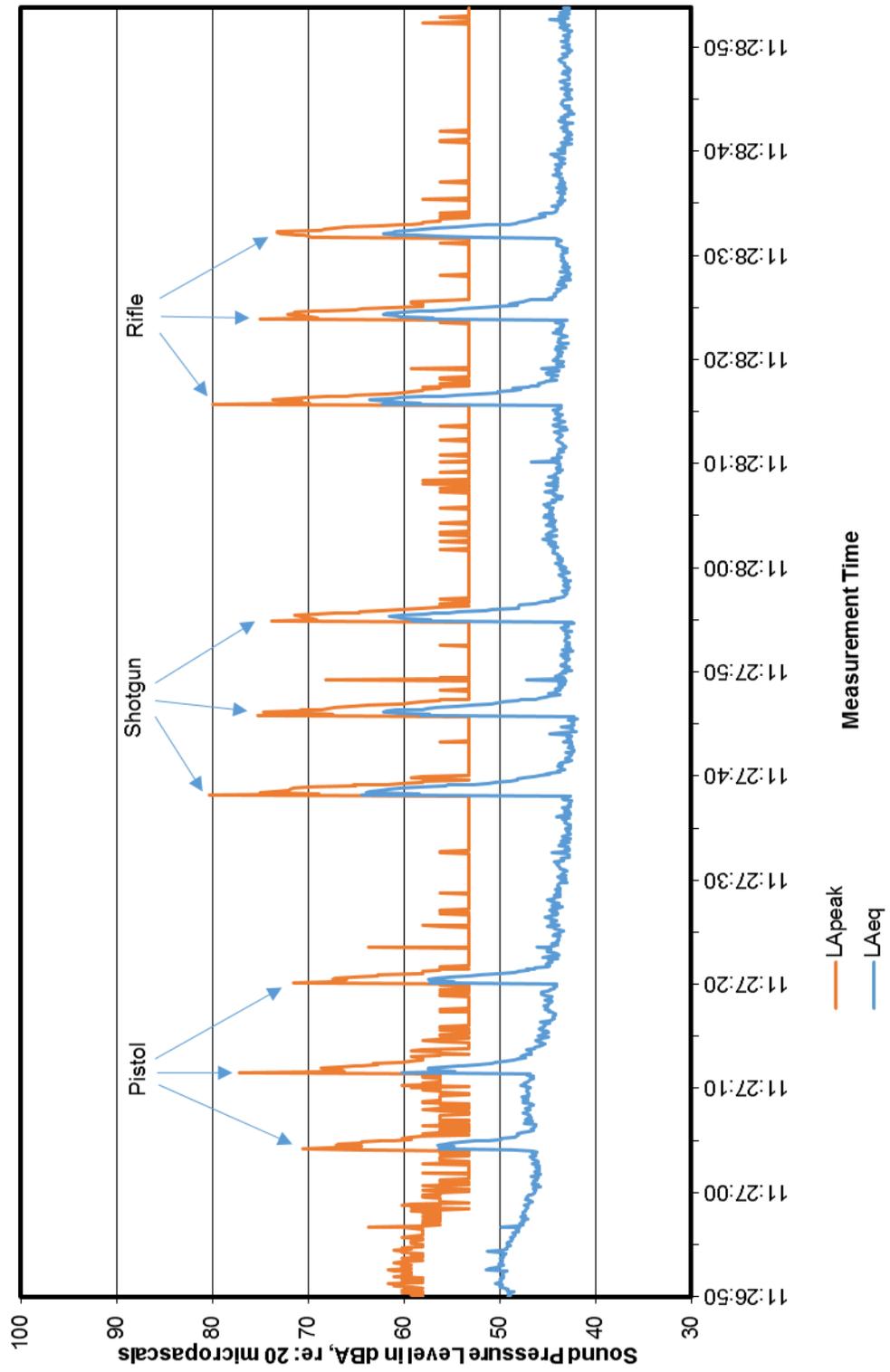
**Michigan DNR 2
Site: Barry
Receiver Location: 5B**



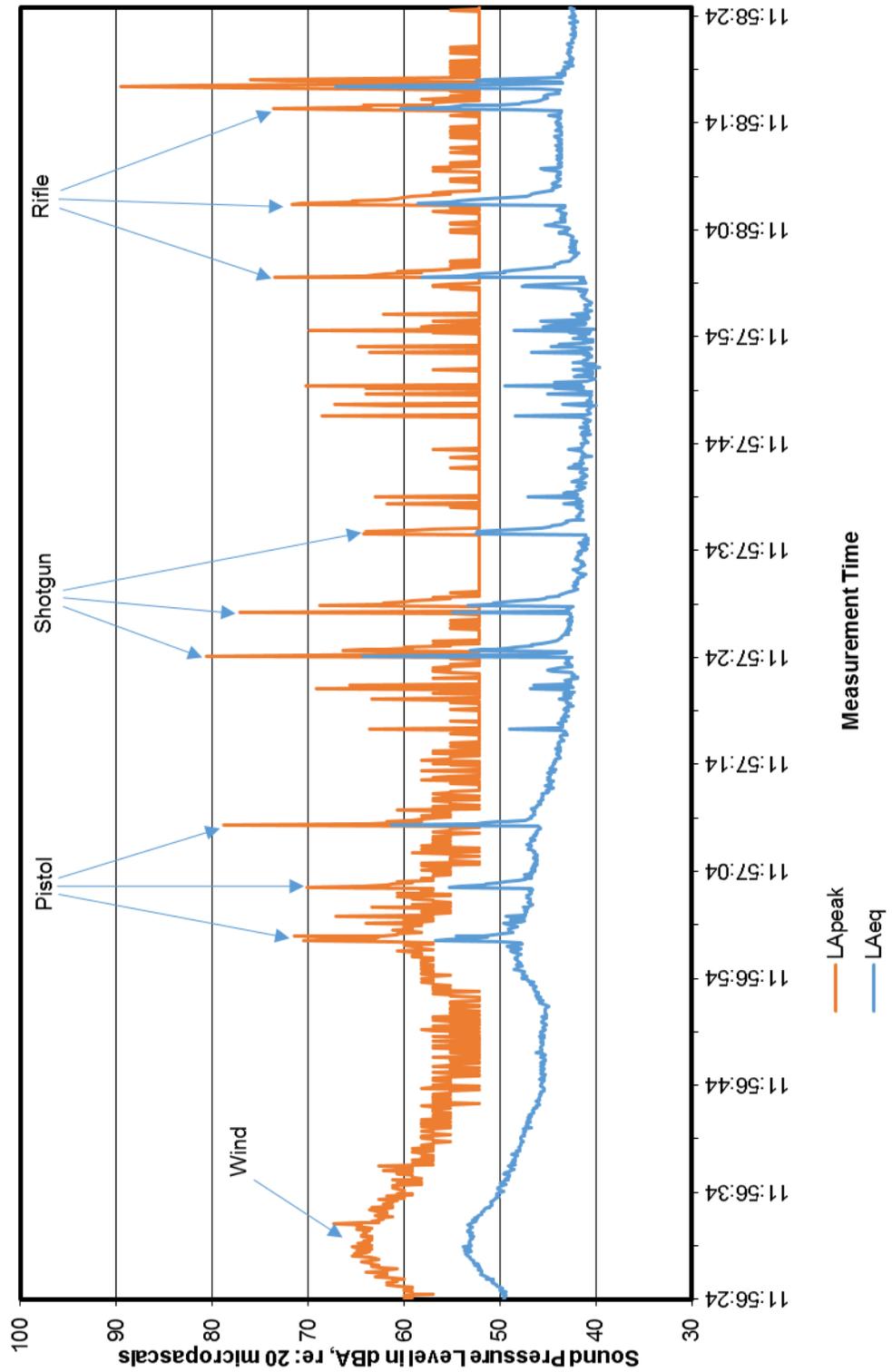
**Michigan DNR 2
Site: Barry
Receiver Location: 6B**



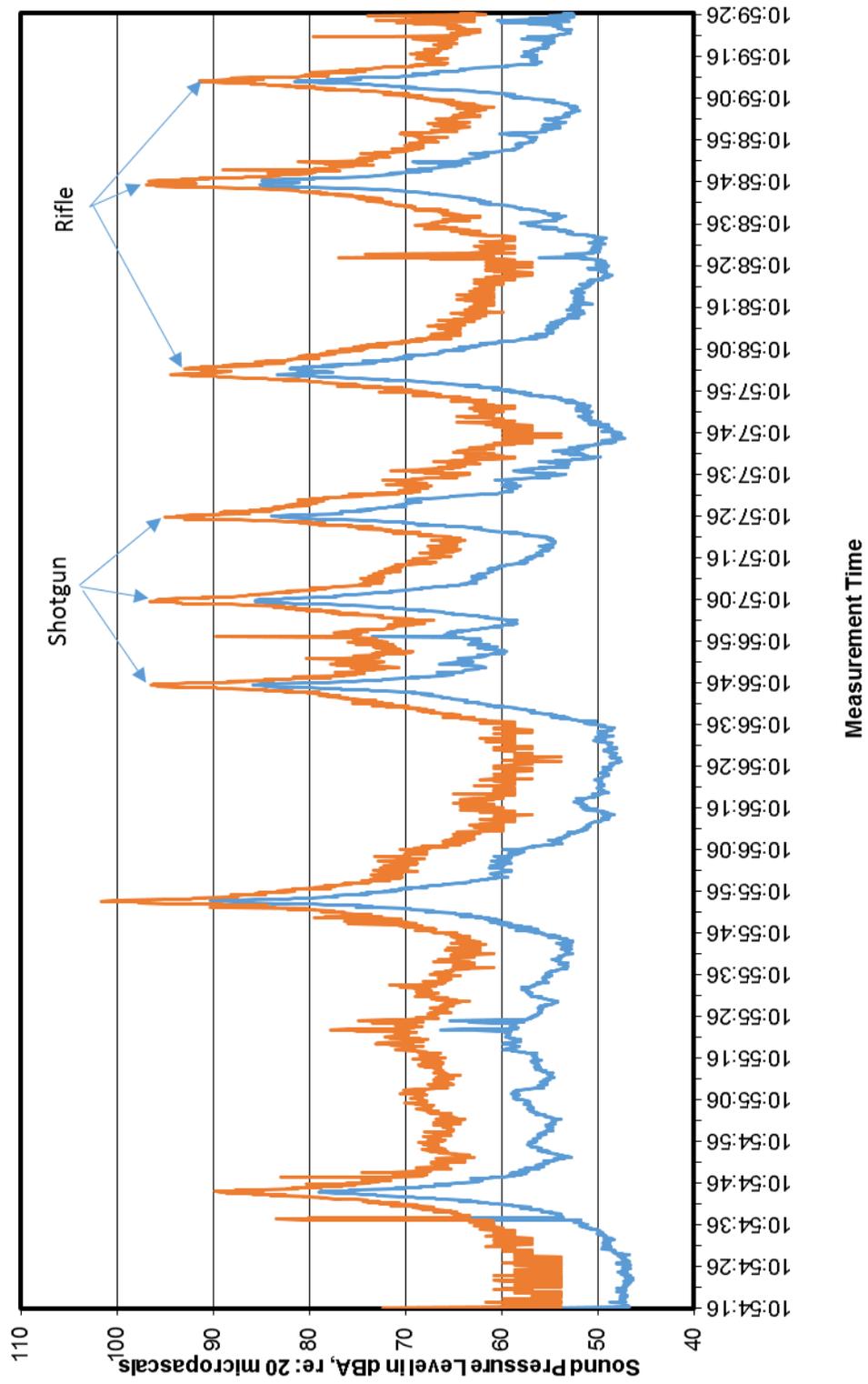
**Michigan DNR 2
Site: Barry
Receiver Location: 7B**



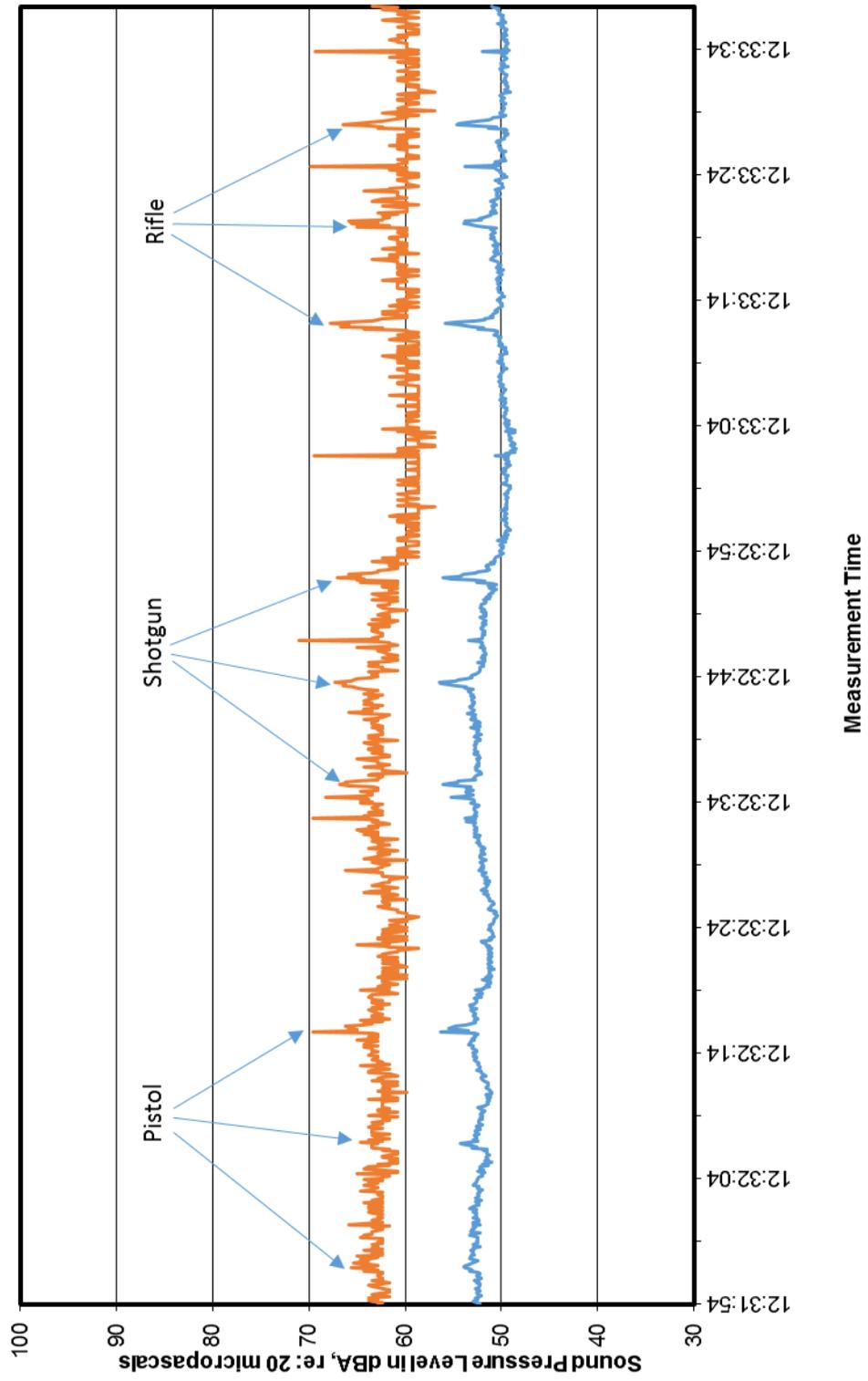
**Michigan DNR 2
Site: Barry
Receiver Location: 8B**



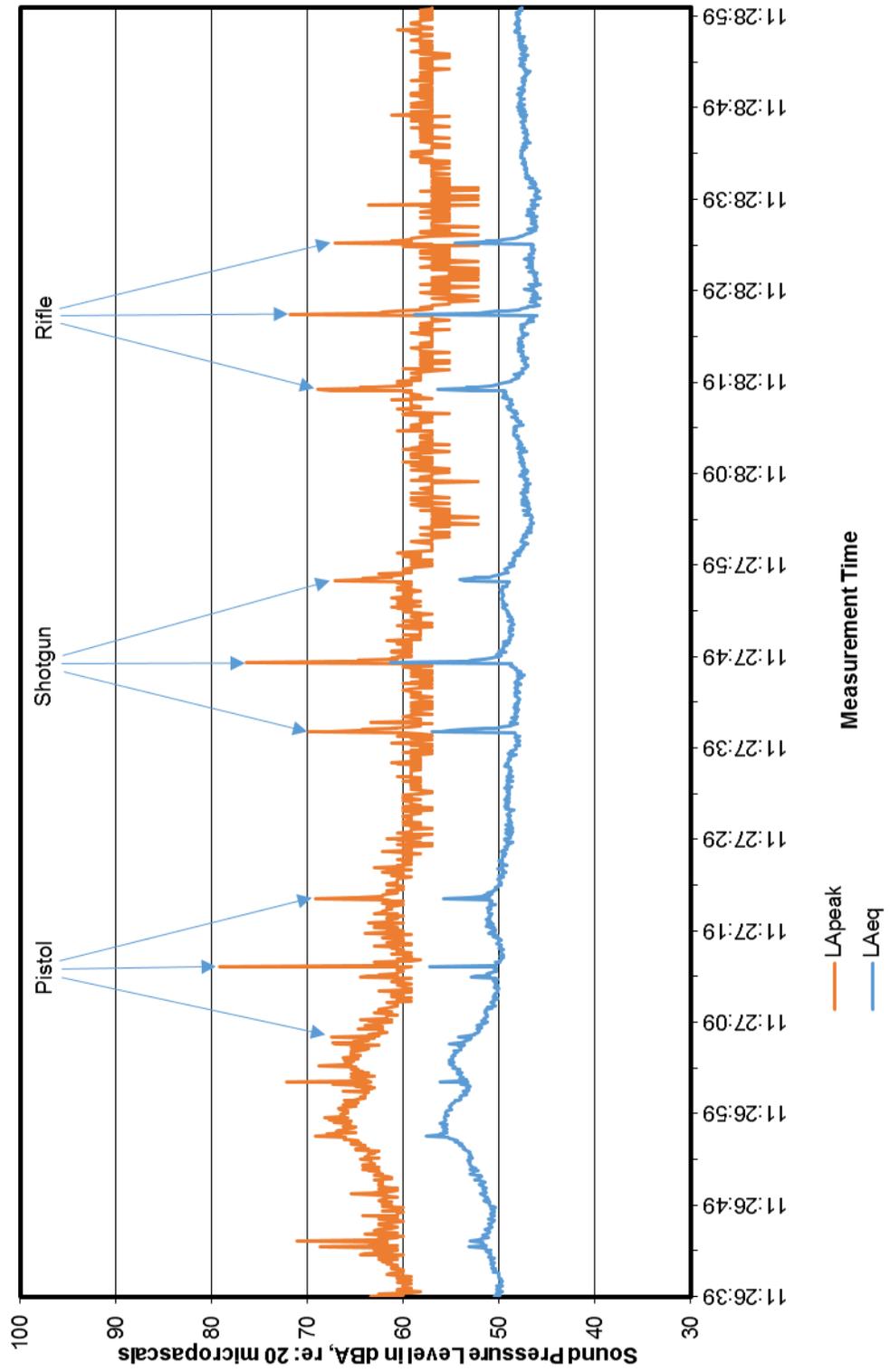
Michigan DNR 2
Site: Barry
Receiver Location: 9B



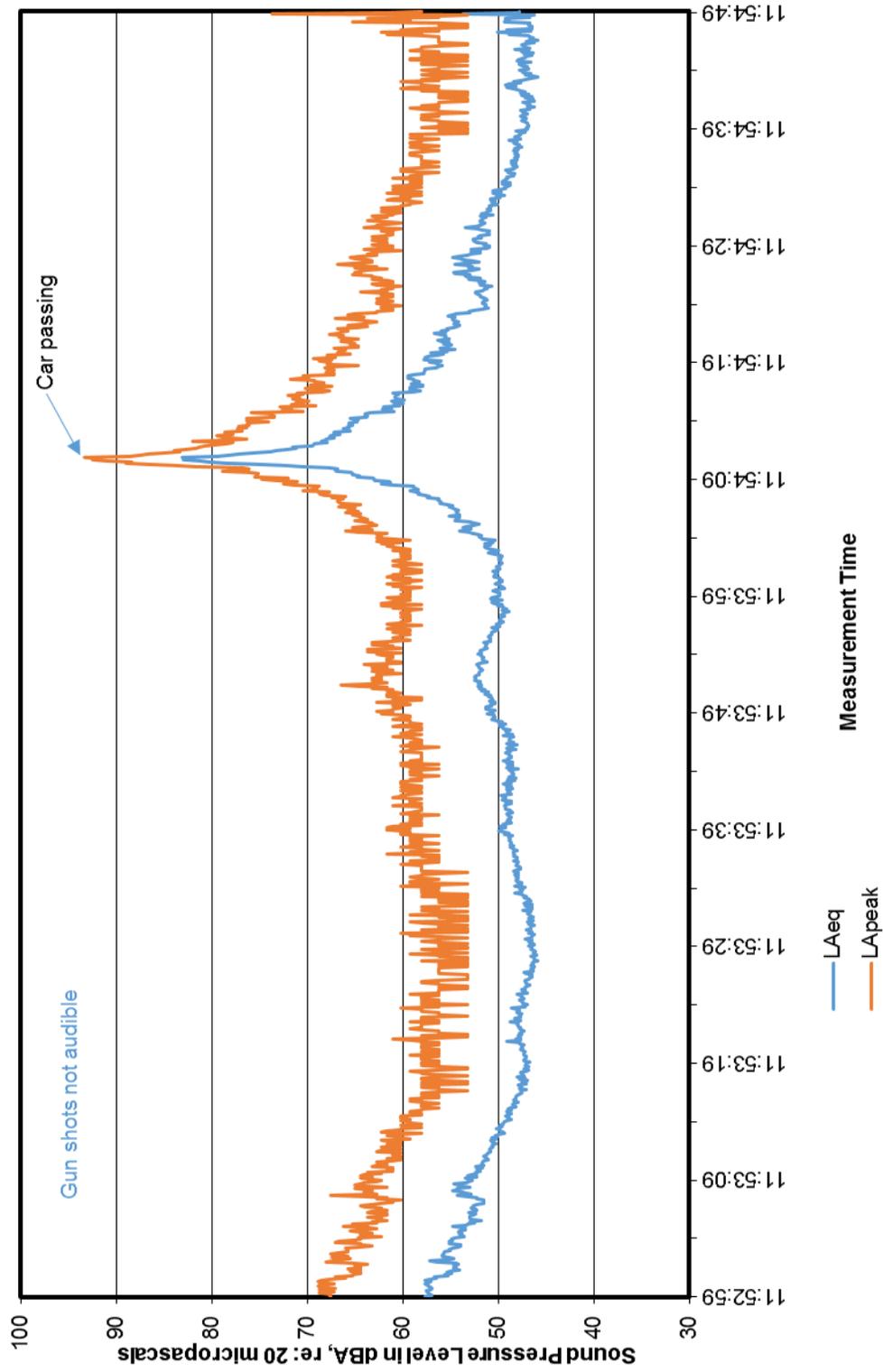
Michigan DNR 2
Site: Barry
Receiver Location: 10B1



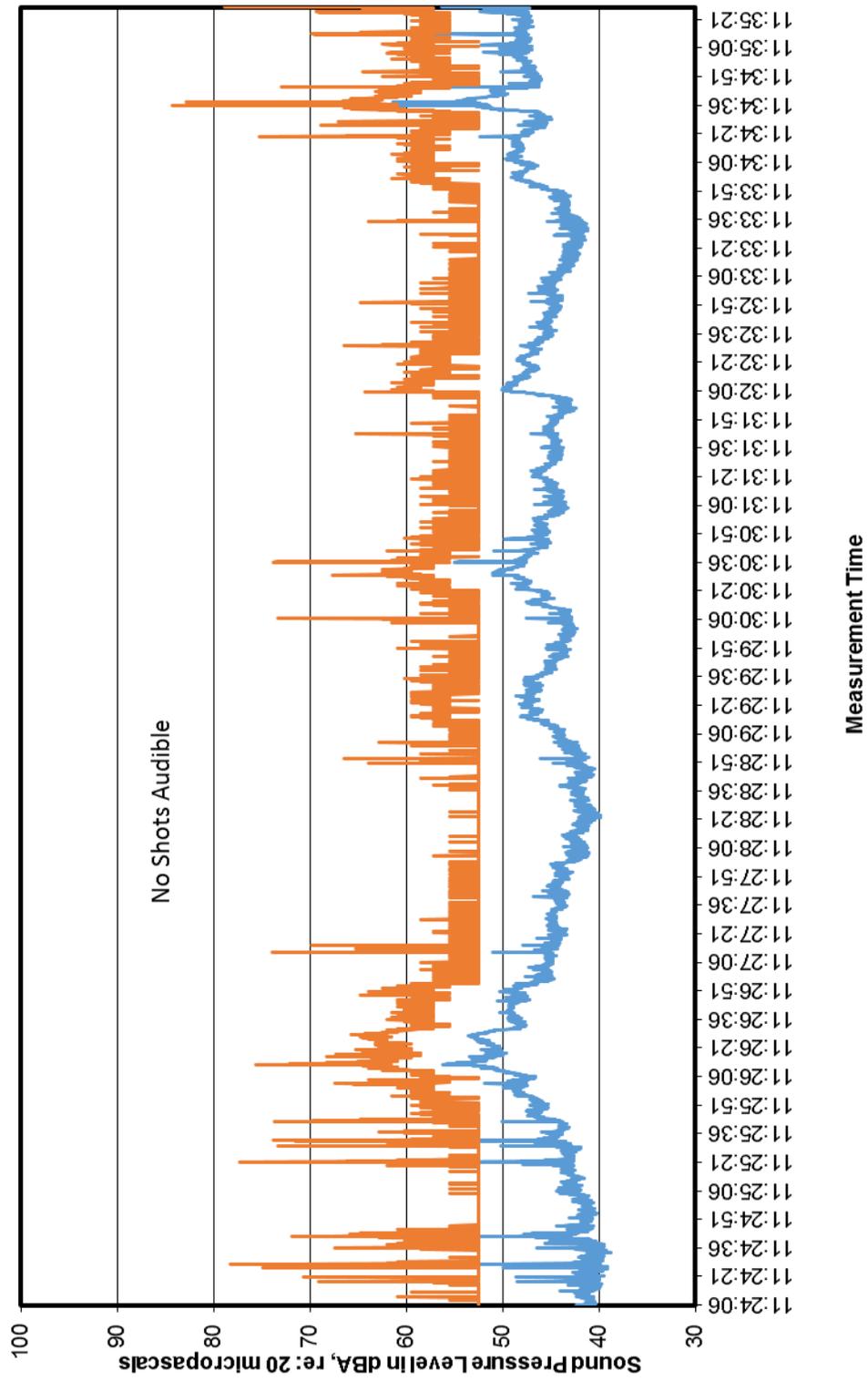
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Site: Barry
Receiver Location: 11B**



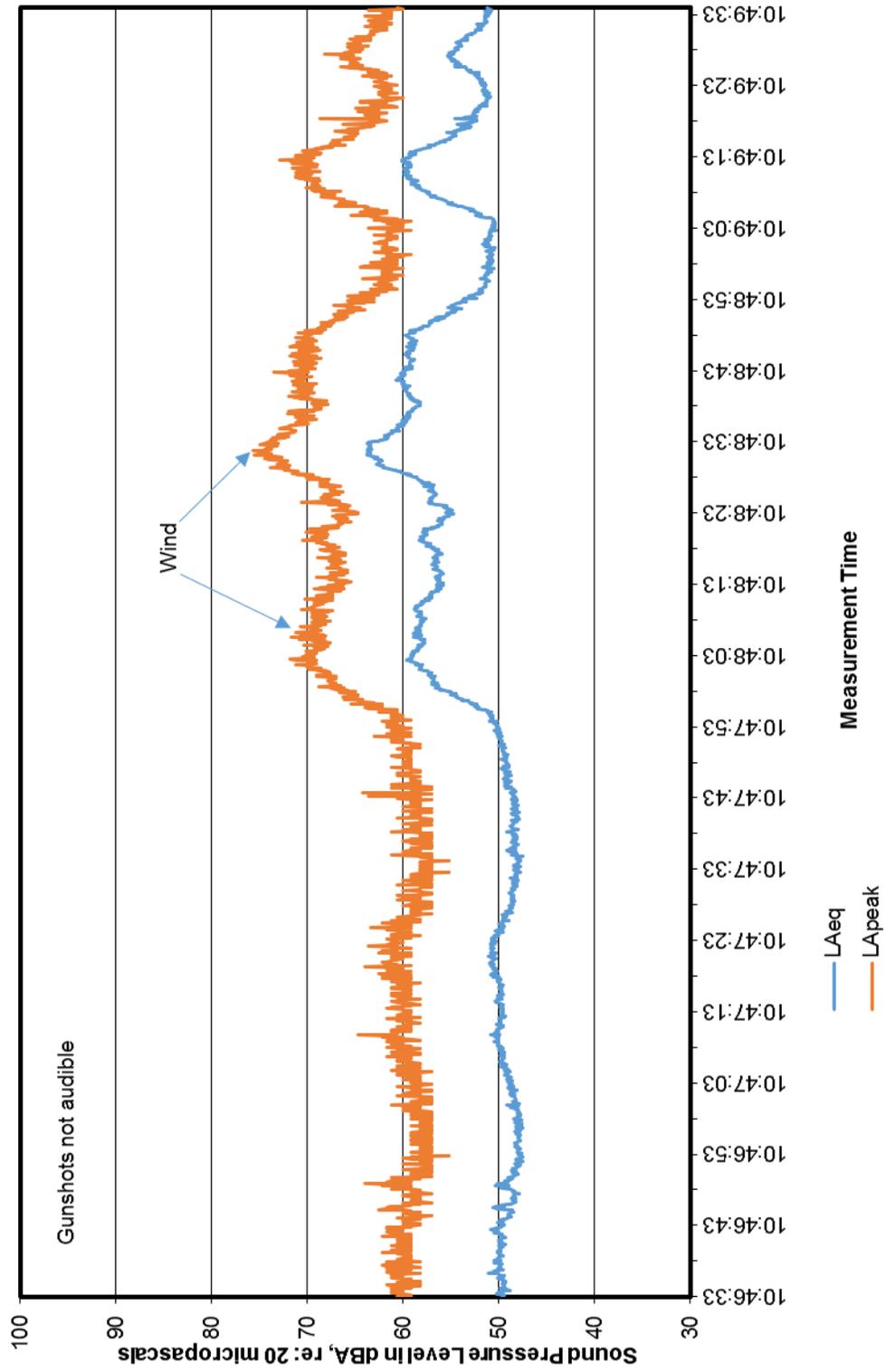
Michigan DNR 2
Site: Barry
Receiver Location: 12B



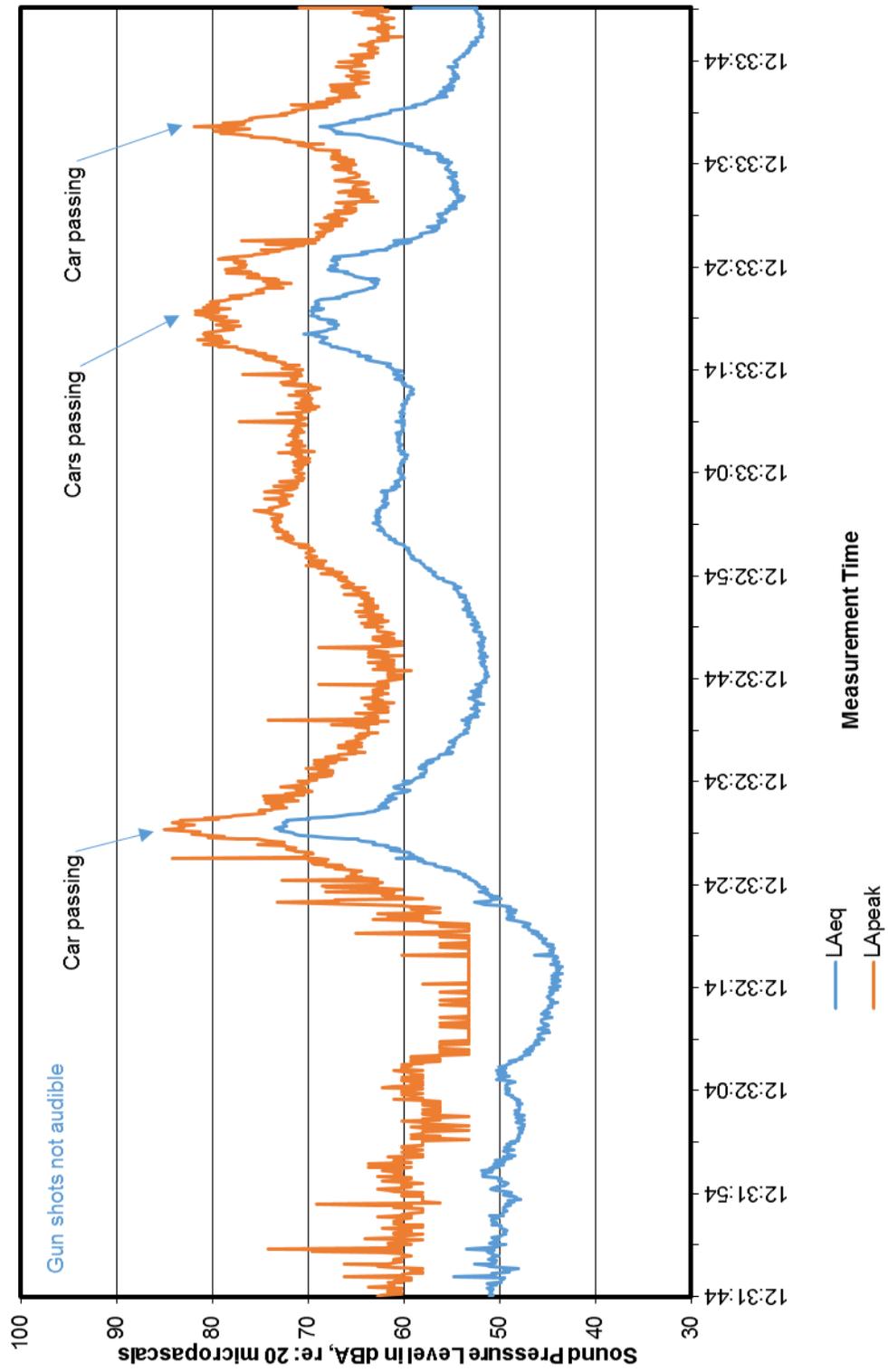
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Site: Barry
Receiver Location: 13B



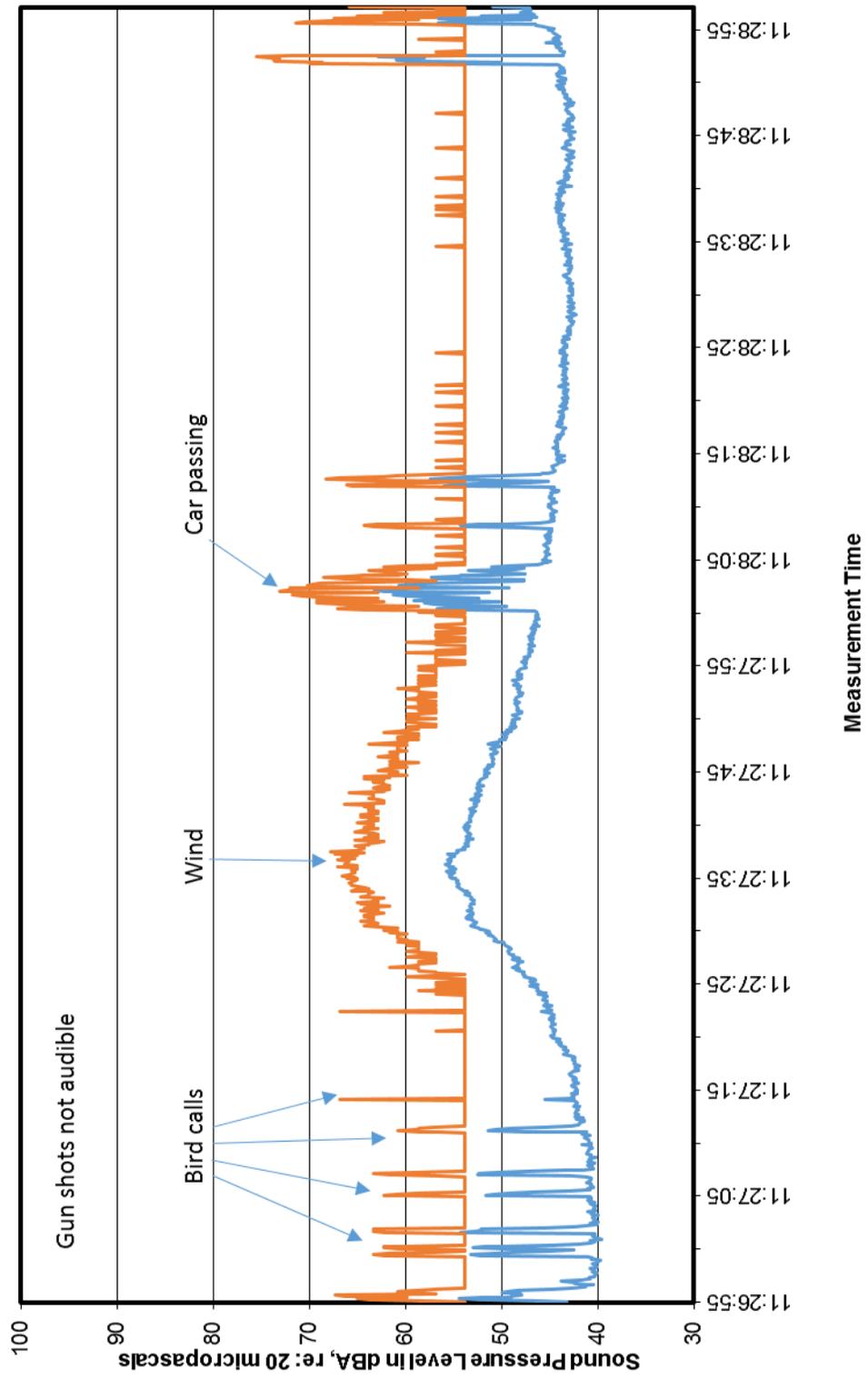
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Site: Barry
Receiver Location: 16B



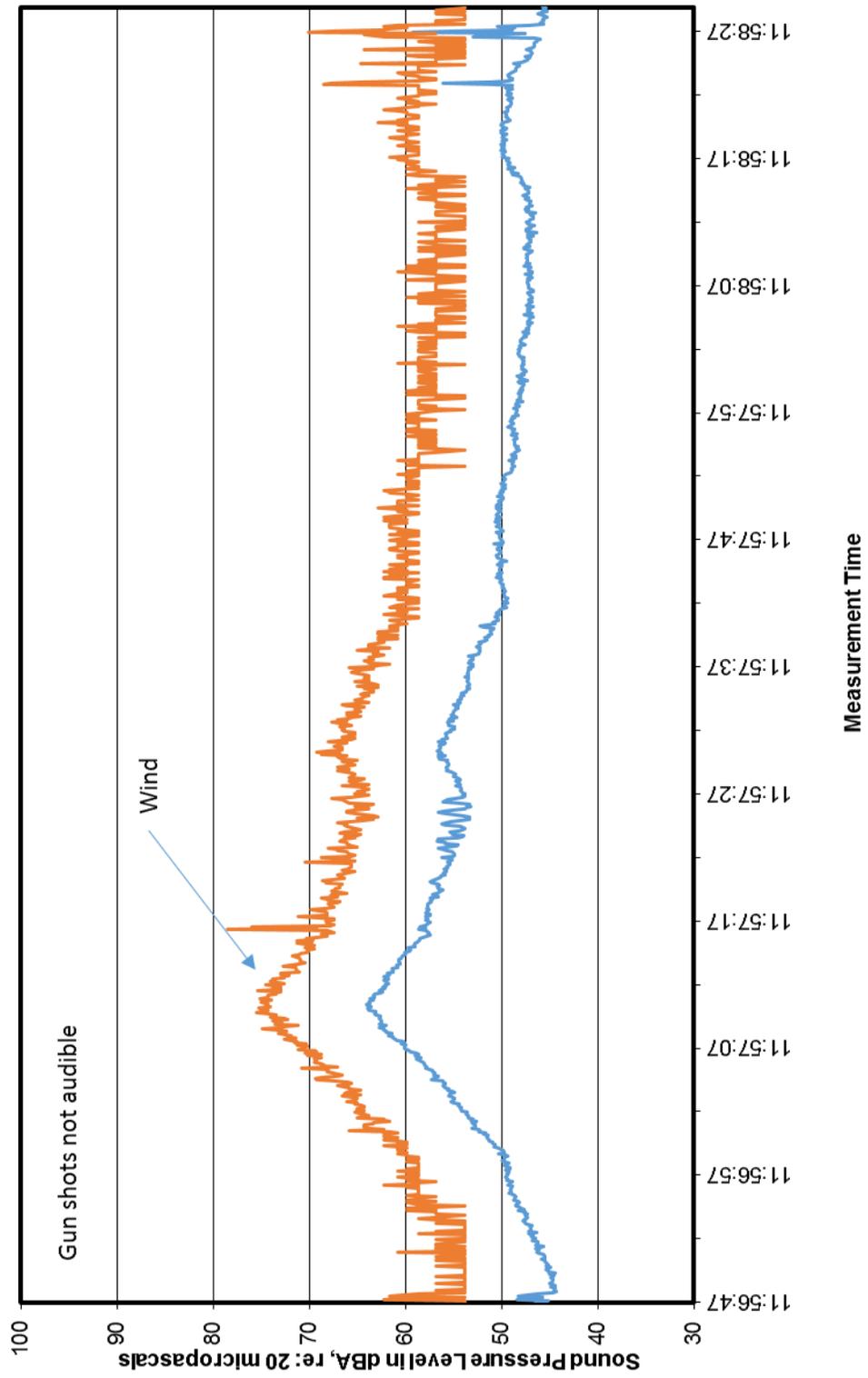
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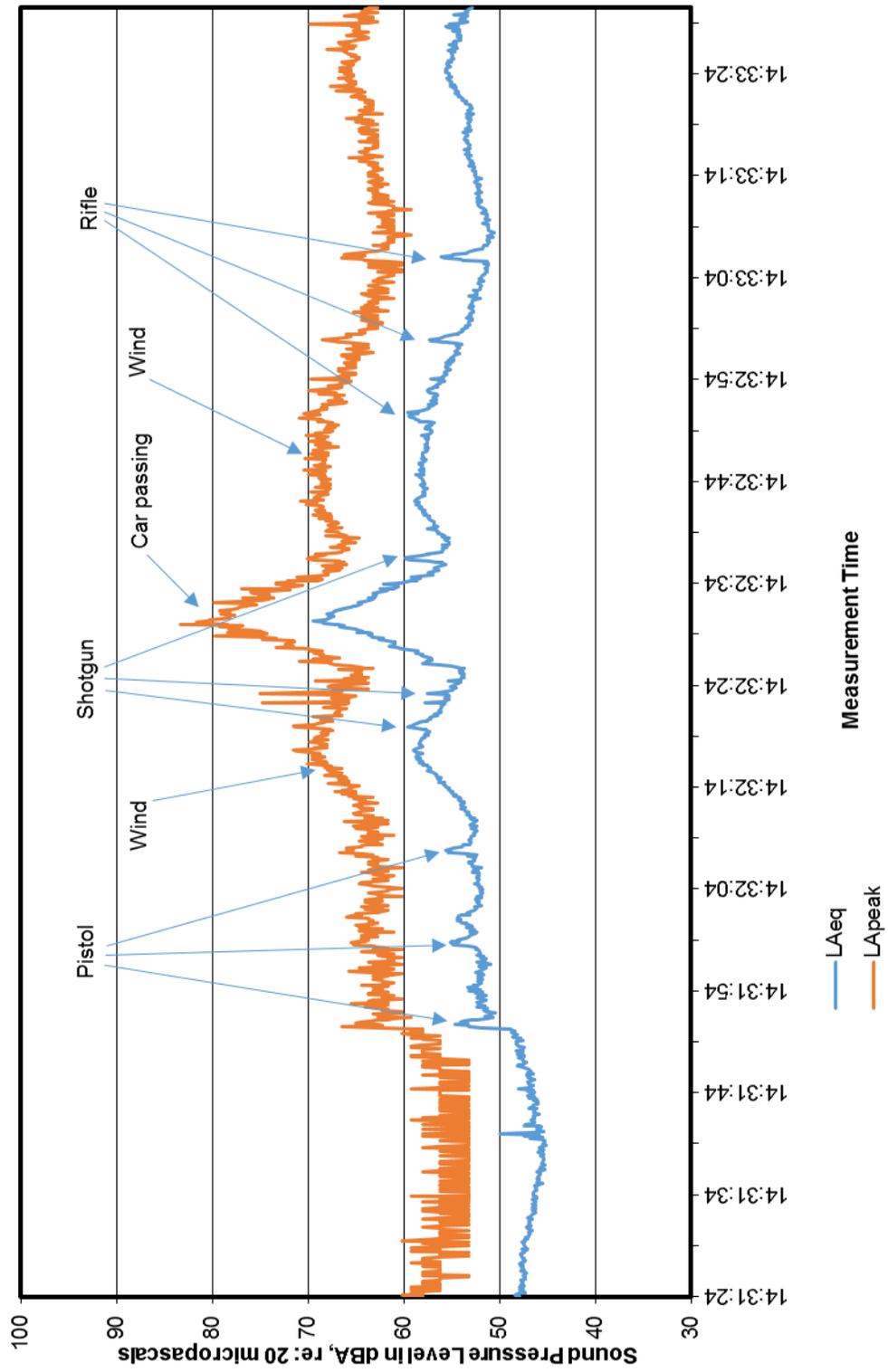
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Site: Barry
Receiver Location: 18B



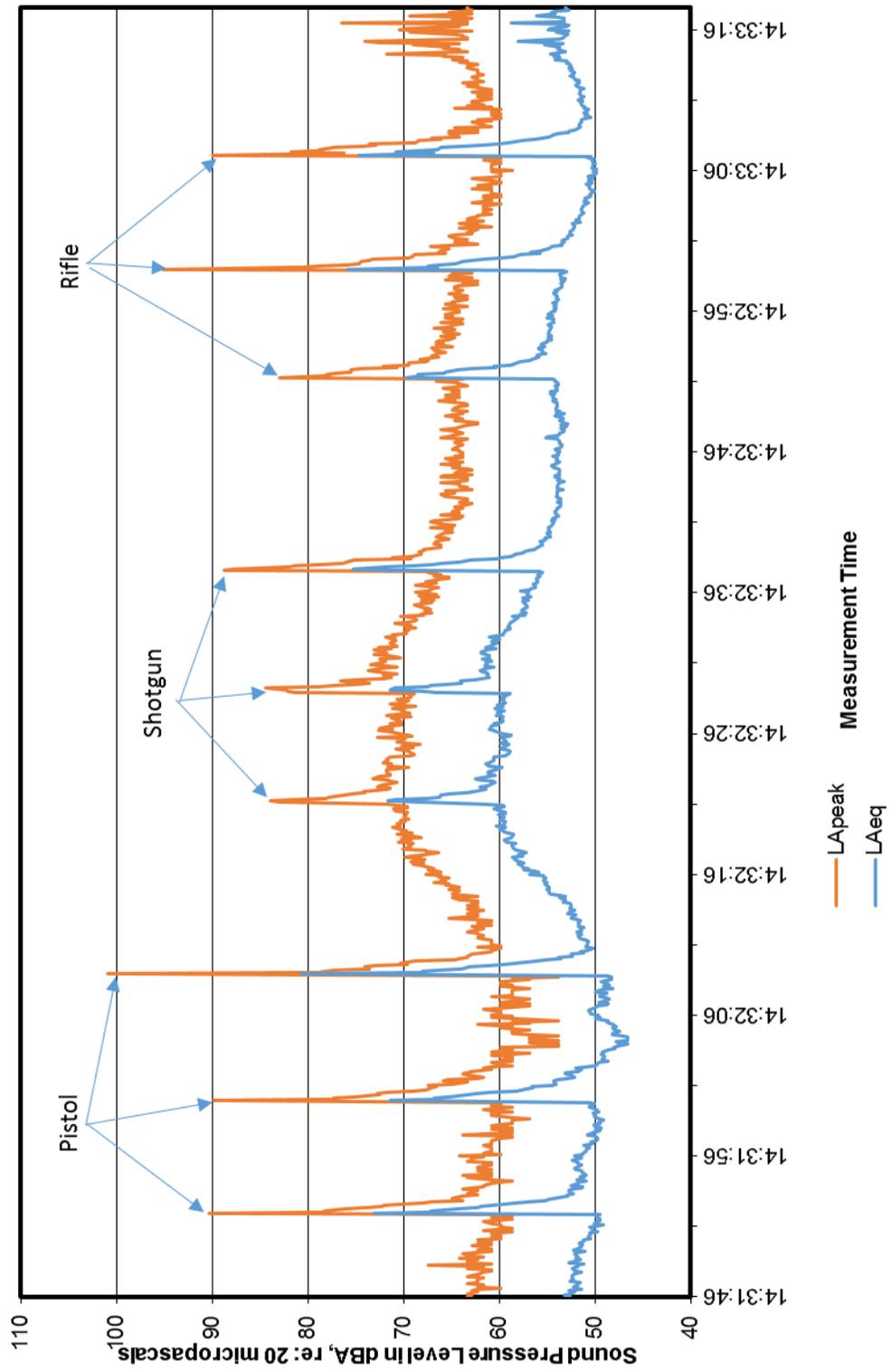
Michigan DNR 2
Site: Barry
Receiver Location: 19B



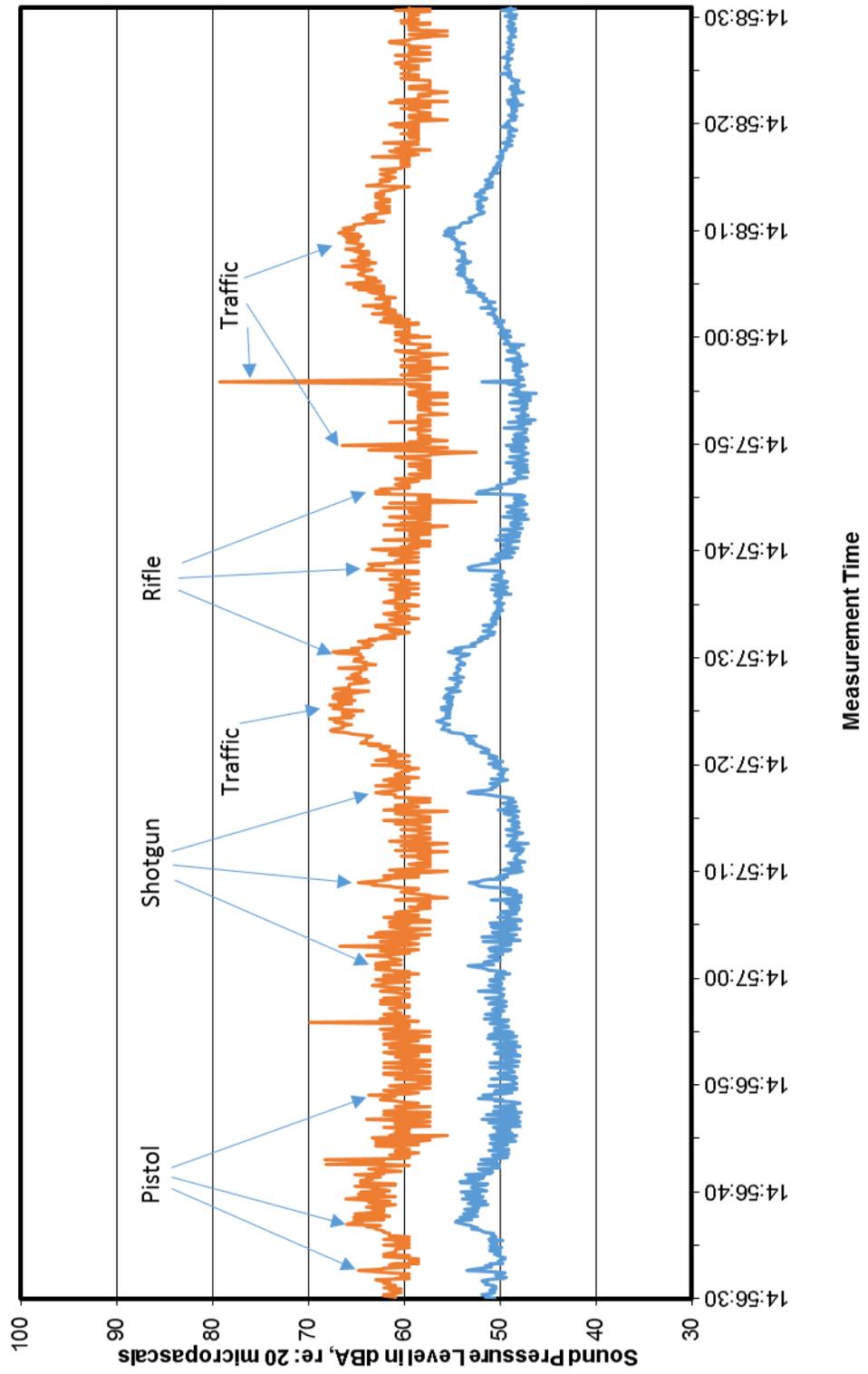
**Michigan DNR 2
Site: Chief Noonday
Receiver Location: 1p**



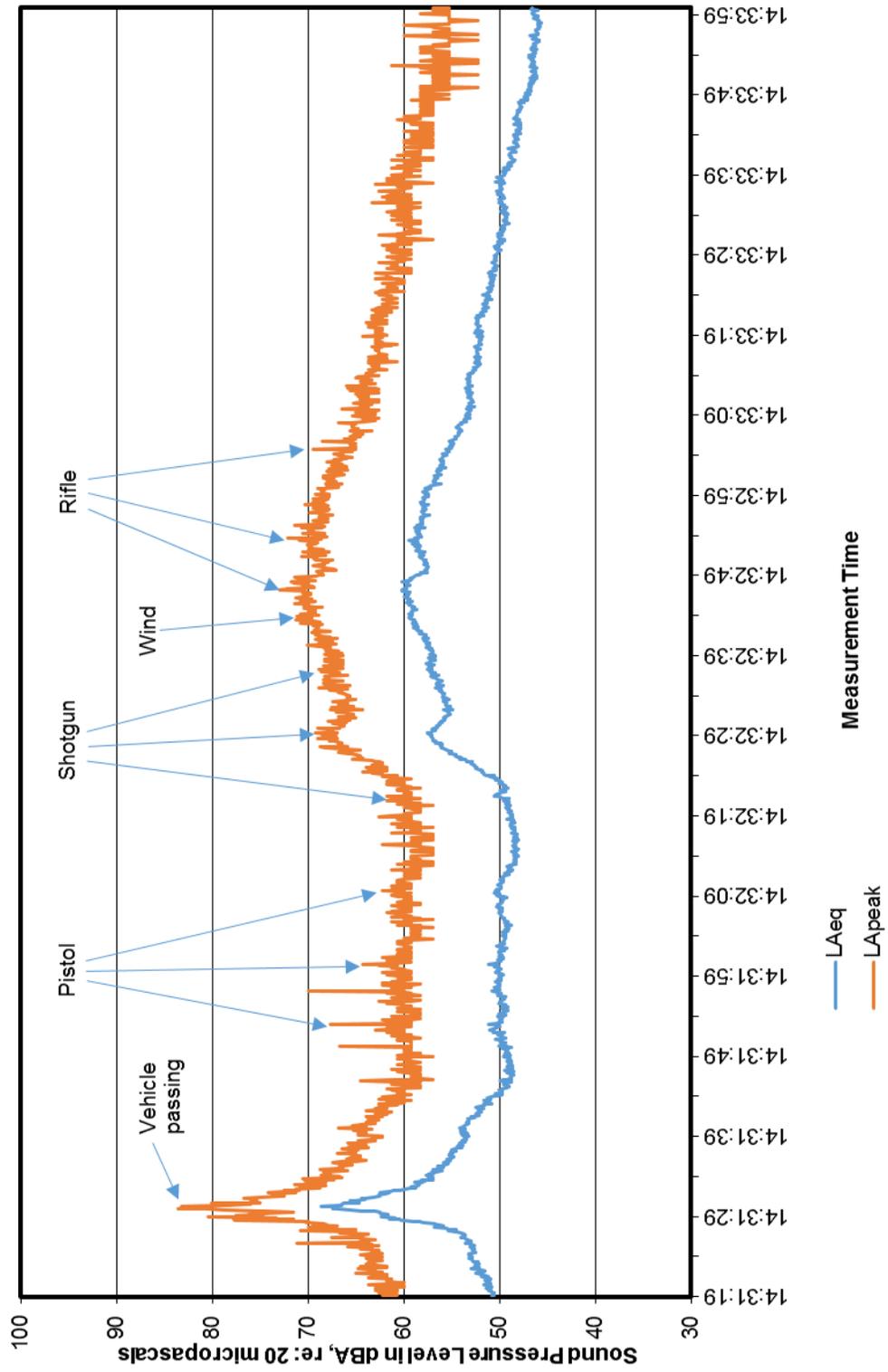
Michigan DNR 2
Site: Chief Noonday
Receiver Location: 2p alt



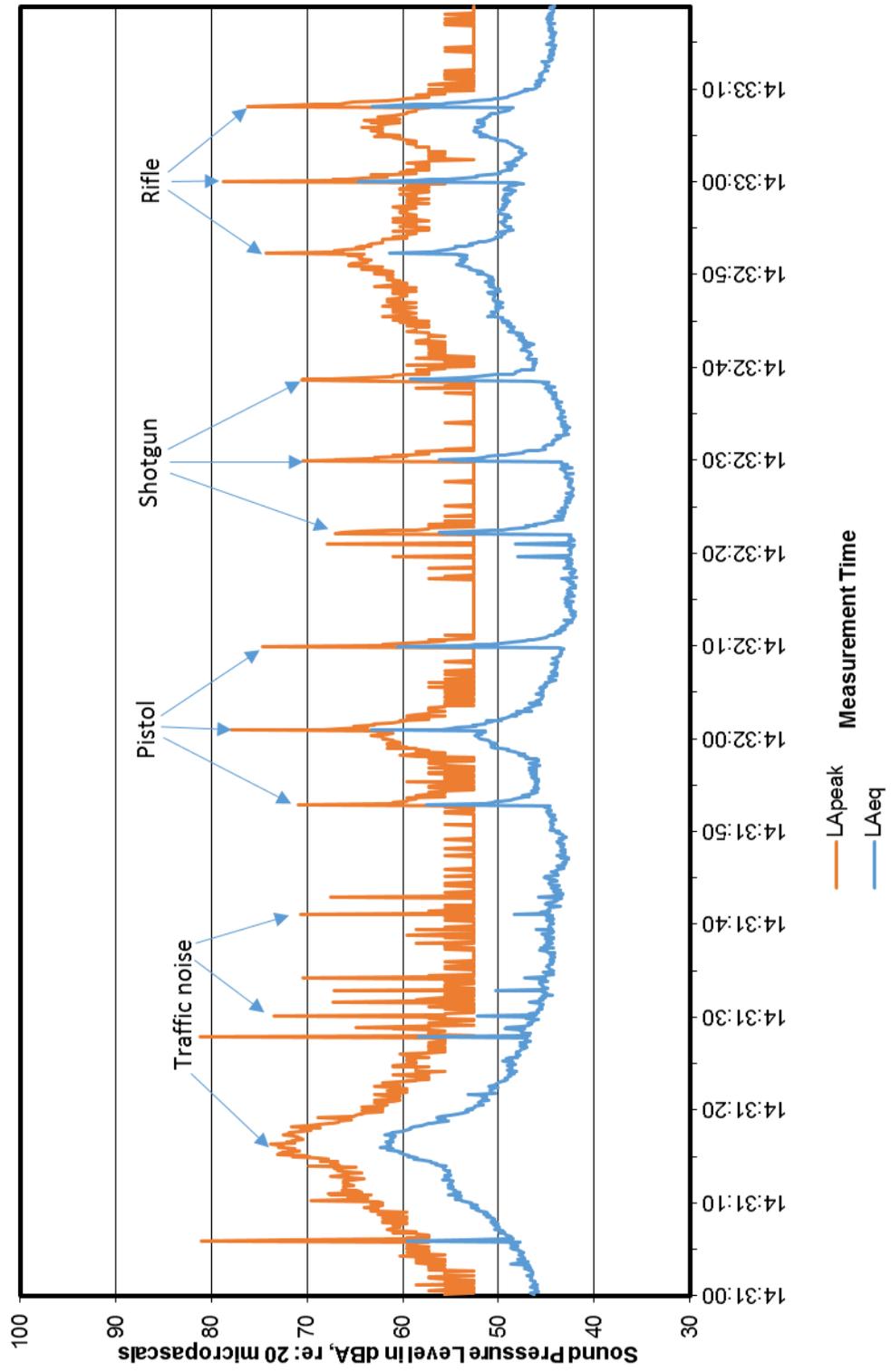
Michigan DNR 2
Site: Chief Noonday
Location: 4p alt



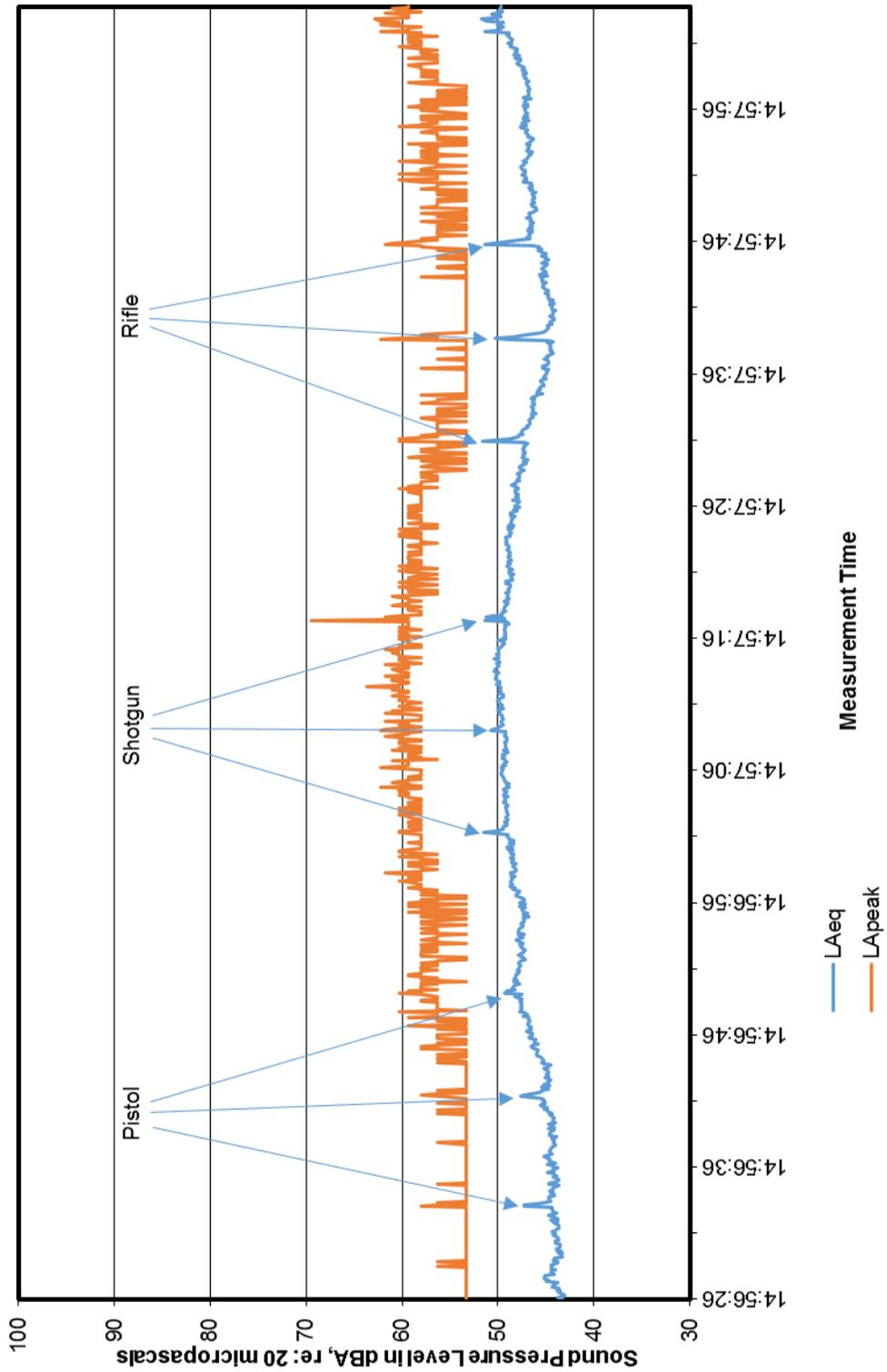
**Michigan DNR 2
Site: Chief Noonday
Receiver Location: 5p**



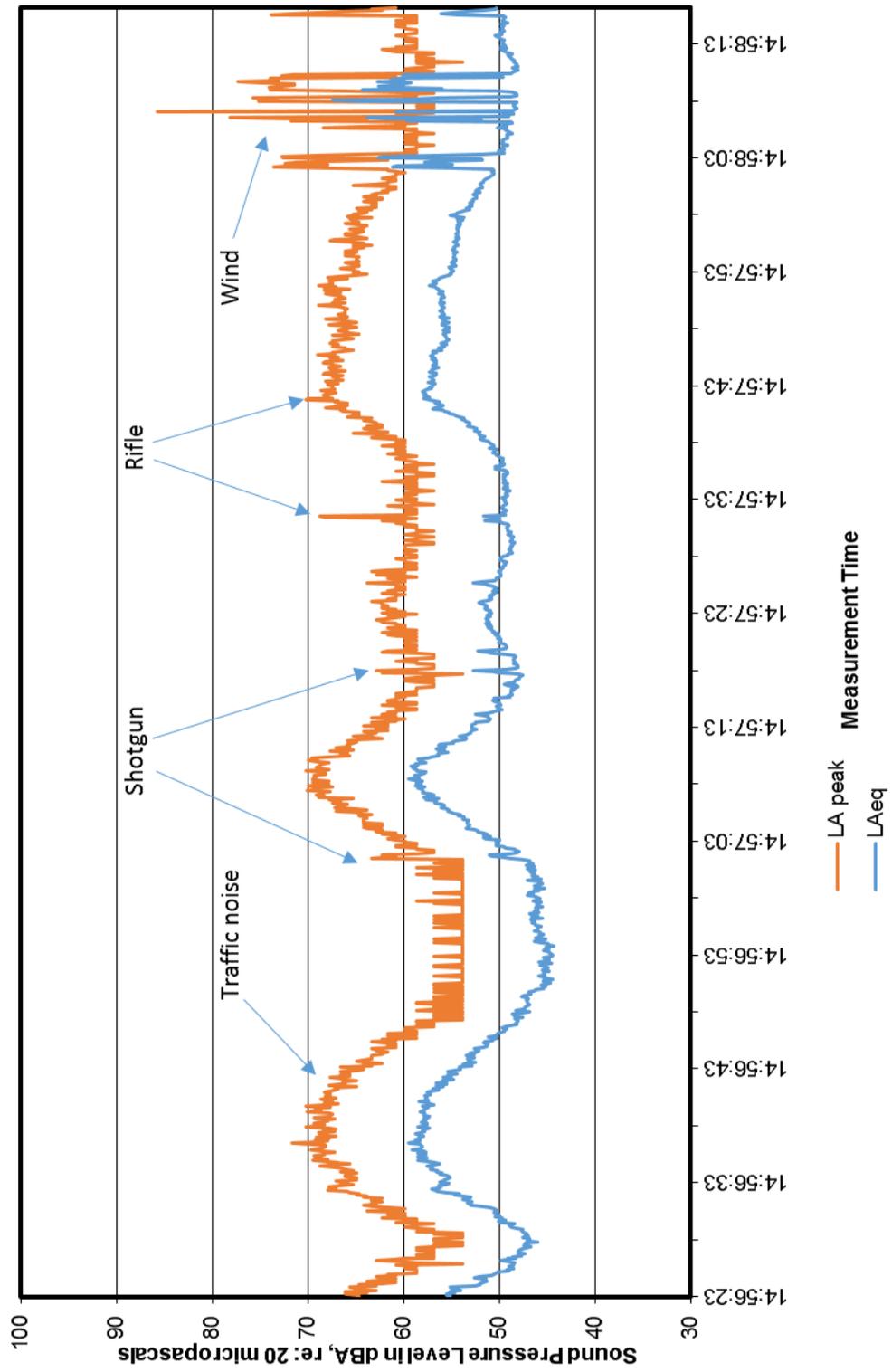
Michigan DNR 2
Site: Chief Noonday
Receiver Location: 6p 1



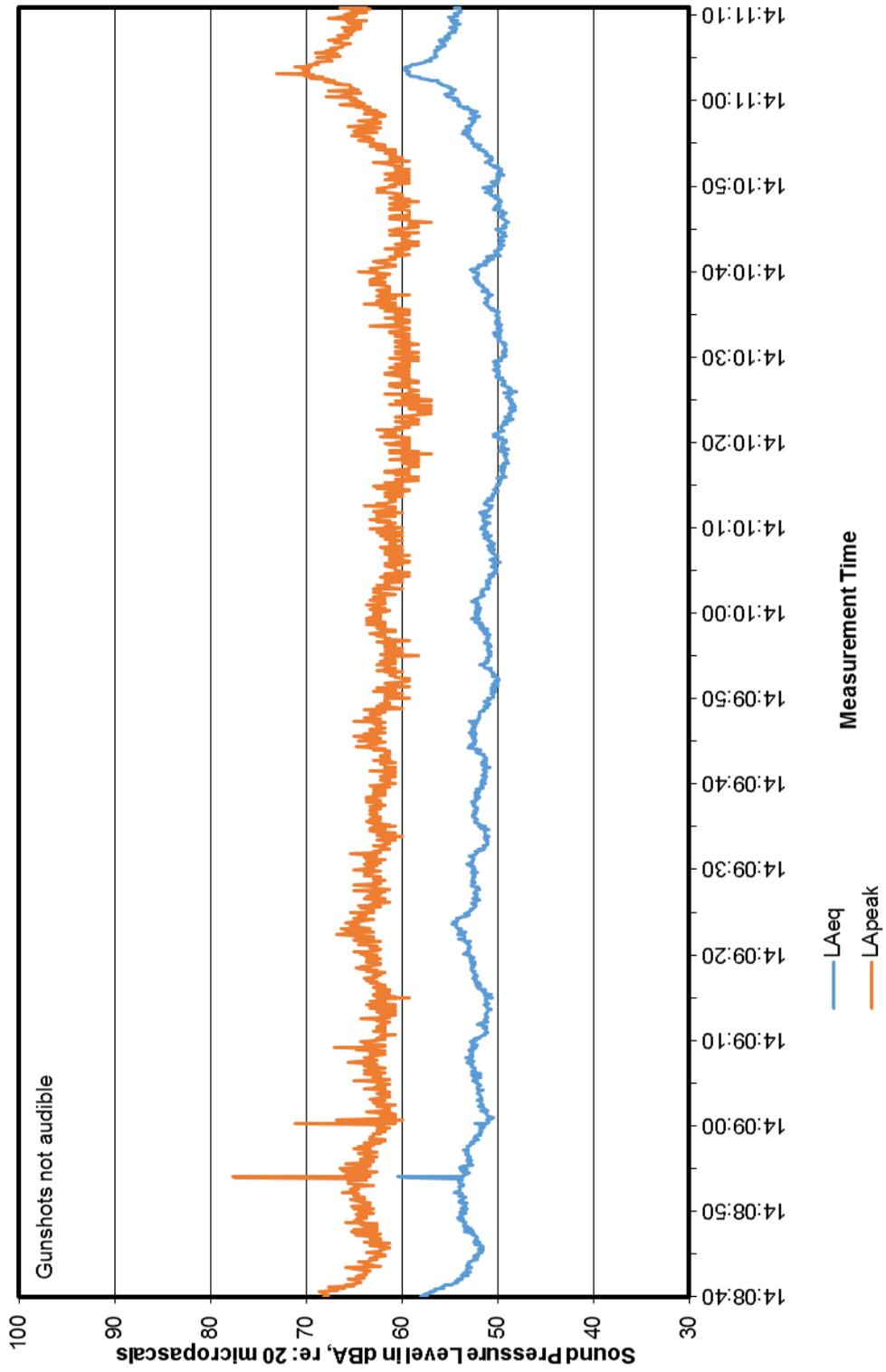
**Michigan DNR 2
Site: Chief Noonday
Receiver Location: 7p**



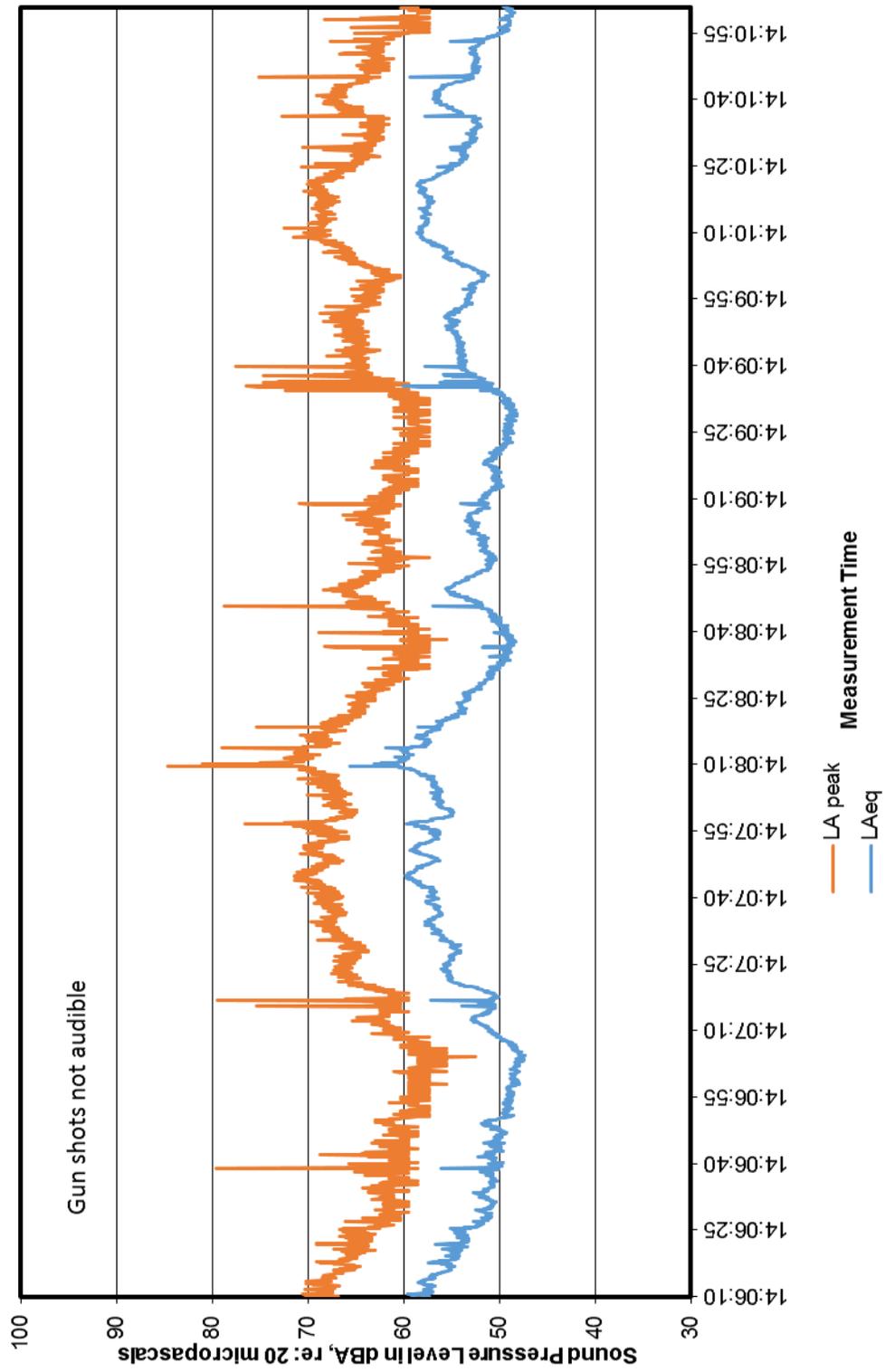
Michigan DNR 2
Site: Chief Noonday
Receiver Location: 8p 1



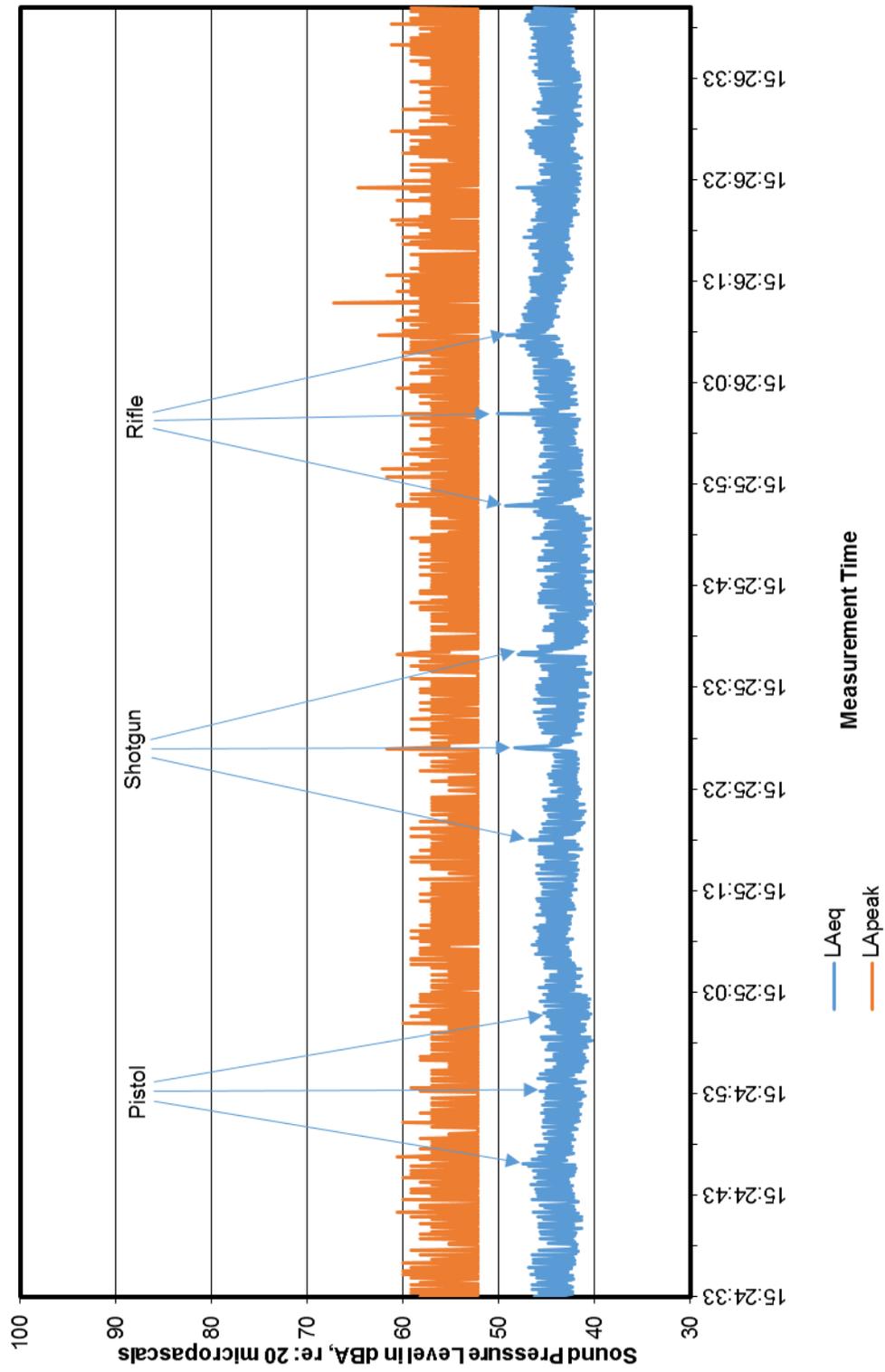
Michigan DNR 2
Site: Chief Noonday
Receiver Location: 9p



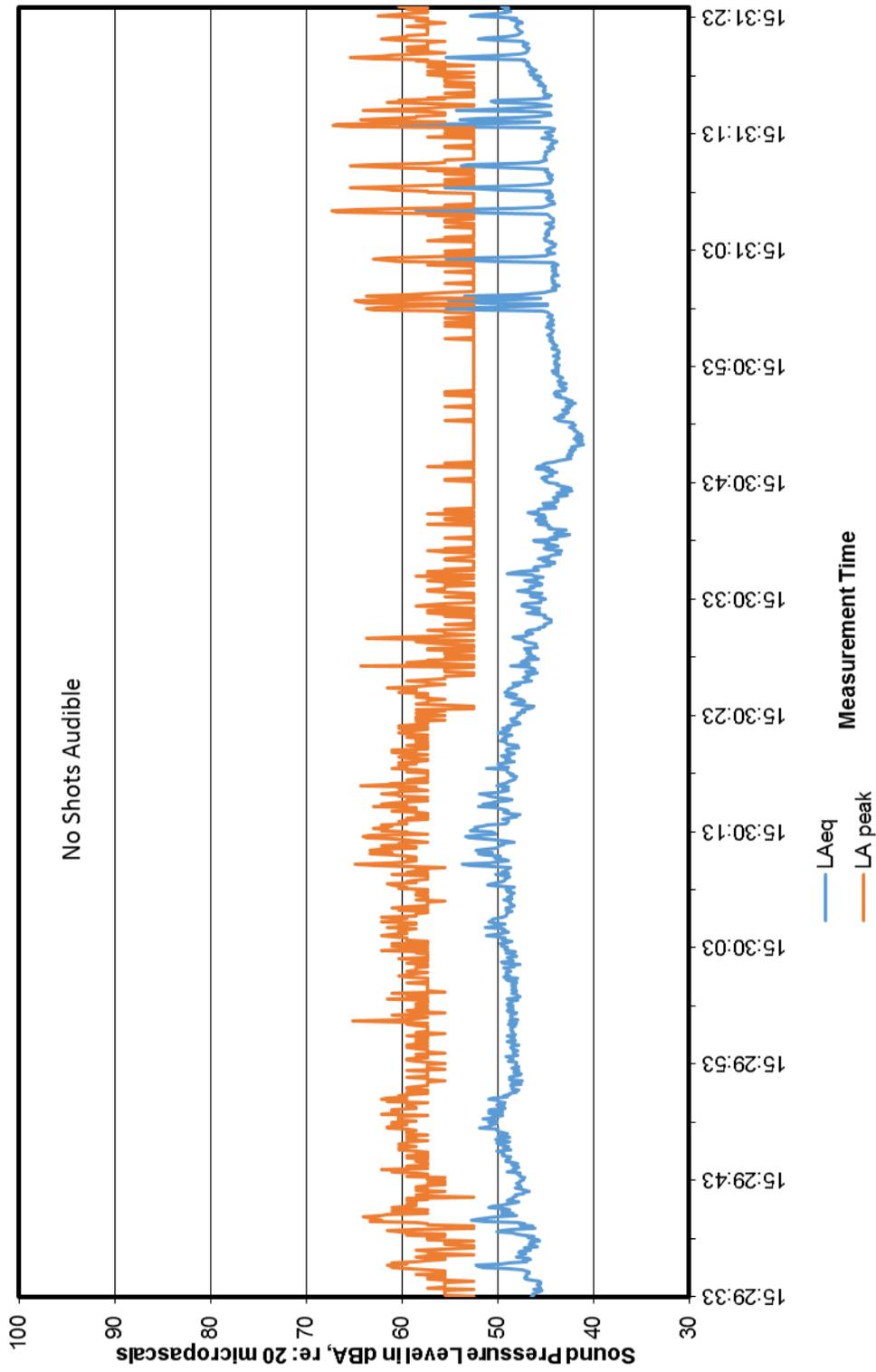
Michigan DNR 2
Site: Chief Noonday
Receiver Location: 10p 1



**Michigan DNR 2
Site: Chief Noontday
Receiver Location: 11p**



**Michigan DNR 2
Site: Chief Noonday
Receiver Location: 12p**



**Michigan DNR 2
Site: Chief Noonday
Receiver Location: 13p**

